JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 40 AUGUST 20, 1959 NO. 3

FIELD OBSERVATIONS ON A HOWLING MONKEY SOCIETY

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The ecology of howling monkeys is better known than that of any other platyrrhines. There have been two recent, intensive field studies of howling monkeys (Carpenter, 1934; Collias and Southwick, 1952) and even the older, fragmentary reports (reviewed in Carpenter, 1934) contained a considerable amount of information about these primates.

This report is based on a field study of howling monkeys, *Alouatta palliata*, on Barro Colorado Island (Canal Zone Biological Area), Panama. During the study, special emphasis was placed on social communication and the ontogeny of behavior.

The study was carried out from October 29 to December 1, 1955. A total of 227 hours was spent on field observations, most of which were made on a single group of howlers. This group is referred to as the "laboratory group" because of the proximity of the group's home range to the Smithsonian Institution's field laboratories. Supplementary observations on five other groups were made.

FIELD CONDITIONS, METHODS AND EQUIPMENT

The howling monkeys that were studied inhabit mature, tropical evergreen forest. They were observed from concealment with the aid of 7×, 50 binoculars. A field compass was used to map the movements of the group. Sound recordings were made by means of a Magnemite Model 610 SD field tape recorder, with an Electrovoice Model 636 microphone mounted at the focal point of an 18-inch parabolic aluminum reflector. Systematic notes were taken while in the field.

The period during which this study was conducted was the last and heaviest part of the rainy season on Barro Colorado Island. The thick foliage at that time of the year and the intense tropical rain often interfered with observation and sound recording. Despite these difficulties, data frequently were obtained faster than they could be written down.

Groups of howling monkeys were most easily located by means of the characteristic roaring vocalizations given by the adult males each morning at sunrise. If, in addition, the location of the trees in which a group had

slept during the preceding night was known, it could readily be relocated on the following morning before the start of the first group progression. If this location was not known, and if the group under study was not found by means of the morning howl, several hours were often required to relocate the group.

Specific individuals within a group could be recognized by combining as many of the following features as possible: age, sex, size, distinctive markings on the fur, individual differences in voice (especially among adult males), associated individuals, the size and location on the body of bots. The last were extremely useful for distinguishing members of the same age and sex category. In addition, after almost a month of observations, many of the individuals came to "look familiar," and could quickly be identified before the diagnostic features were consciously considered.

Conversely, a particular group could be identified on the basis of the individuals in it, combined with the location in which found, once the limits of the home range had been fairly well determined.

LOCOMOTION AND MANIPULATION

Most of my observations on individual movements are essentially a confirmation of the extensive descriptions given by Carpenter (1934) and will not be repeated here. The following notes supplement what is already known.

In climbing down vertical lianas, the howlers descended head first. The hands moved forward in unison, then regrasped the liana. After this, both feet and the tail moved down and regrasped. The process was then repeated.

While hanging upside down from a liana by the feet and tail, a howler sometimes reached food on adjacent branches by extending the legs while holding the back straight, thus bringing the head almost a body length from the liana. Exactly the same technique was used by the two-toed anteater, *Cyclopes didactylus*, on Barro Colorado to get from one limb to another.

Some additional observations on locomotion and manipulation will be given in the sections on food, maternal behavior and infant development.

FEEDING BEHAVIOR AND FOOD

During the first two weeks of the present study, about 95 per cent of the diet of the howlers of the laboratory group consisted of figs. After that, the diet shifted to about 50 per cent figs, the remaining half consisting of a wide variety of leaves, particularly young ones from fig trees, and of various fruits, nuts and blossoms. The figs that the howlers ate were green, about an inch long, often infested with insect larvae, and, by human standards, unripe and almost tasteless. Carpenter (1934) gives a list of foods eaten by howlers during the dry season.

Howlers waste much of their food by dropping it, both during the dry season (Carpenter, 1934) and the rainy season. In both cases, the home ranges of the groups contained far more food than they utilized. It seems doubtful, therefore, that the food supply is limiting population density.

Although locating food trees was a social phenomenon in the sense that it depended upon whatever social interactions determined the distance and direction of group movements, the actual feeding process was, with the exception of nursing, an individual activity. The howlers neither cooperated nor competed in obtaining food.

During feeding, the howlers stood on four feet, sat, hung by the tail and hind legs, or hung by the tail alone. Branches containing food were pulled toward the monkey with

one or, more frequently, with both hands. The fruit was then bitten off. Less accessible fruits were obtained by bending the branch containing the fruit with a hand-over-hand movement from the proximal toward the distal portion of the branch. The fruit was then bitten off. With few exceptions, the figs themselves were not handled by the howlers. The latex of these figs becomes very sticky as it dries.

GROUP COMPOSITION

Howling monkeys live in distinct groups, each of which occupies a particular region of the forest. With the possible exception of complemental males (Carpenter, 1934), there are no known shifts of members from one such group to another. Thus, these groups constitute closed societies.

The compositions of the laboratory group during the present study and of the group of howlers in the canyon of Lutz Stream (Fig. 1) during several previous censuses are

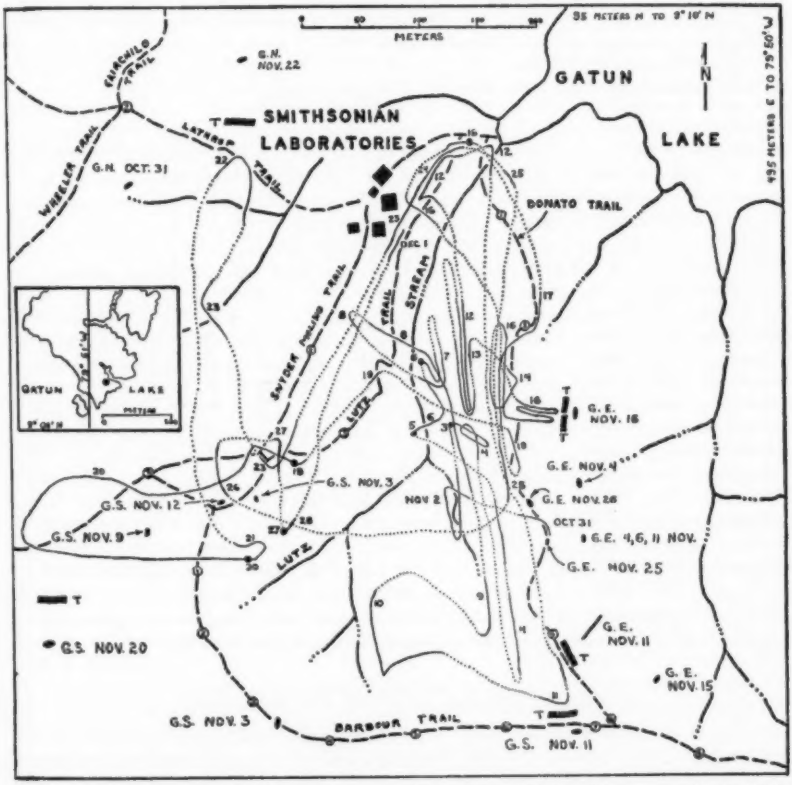

FIG. 1.—Movements of the laboratory group of monkeys, October 31 to December 1, 1955. Observed positions are shown by solid lines, known night resting places by large dots. Observed locations and dates of three adjacent groups are also given (G.E. = group east; G.N. = group north; G.S. = group south). Short, heavy lines (T) indicate the midline between groups during five observed territorial disputes. *Insert:* Location of peninsula group (dot) on November 30, 1955.

given in Table 1. The criteria for distinguishing the age categories that have been used are given by Carpenter (1934). Although there is no record of group boundaries between the censuses, it seems a reasonable assumption that these howlers are probably all part of the same lineage. Surveys of group composition of howling monkeys on Barro Colorado Island have been made in 1932, 1933 (Carpenter, 1934), 1935 (Carpenter, 1953), and 1951 (Collias and Southwick, 1952).

Two other adult males were seen in the laboratory group until November 3. The fate of these males is not known. In addition, the body of a juvenile howler was found during the second week of November on Barbour trail (Fig. 1) at 4.0.

The laboratory group of 1932 and 1933 ranged more widely (Carpenter, 1934). Sometime between 1933 and 1951 the group may have split into two groups, the one still occupying Lutz Stream canyon, and the adjacent group to the south (Collias and Southwick, 1952). The group that now ranges north of the laboratory, on Fairchild Peninsula, may also have arisen from the laboratory group between 1933 and 1937 (Chapman, 1938).

A complete census was made of one other group (peninsula group, Table 1) on the southernmost peninsula of Barro Colorado Island (Fig. 1) on November 30, 1955. In addition, partial censuses of the three groups (south, east and north, Table 1) that occupied the territories adjacent to that of the laboratory group were made.

TABLE 1.—*Censuses of the laboratory group (1924–1955) and of four other groups (1955) of howling monkeys on Barro Colorado Island*

GROUP	TIME OF CENSUS	INFANTS			JUVENILES			FEMALES WITH INFANTS	OTHER ADULT FEMALES	ADULT MALES	TOTAL	REFERENCE
		1	2	3	1	2	3					
Laboratory	Dec. 1924										13	Chapman, 1938
Laboratory	Jan. 1932		4*			8*		4	7	3	26	Carpenter, 1934
Laboratory	May 1932		1*			11*		1	10	4	27	Carpenter, 1934
Laboratory	Jan. 1933		5*			10*		5	5	4	29	Carpenter, 1934
Laboratory	May 1933		3*			10*		3	9	5	30	Carpenter, 1934
Laboratory	Jan. 1937										40	Chapman, 1938
Laboratory	July 1949										32	C. and S., 1952
Laboratory	Mar. 1951		2	1	1	1	2	3	6	1	17	C. and S., 1952
Laboratory	Nov. 1955	1		2	2	1	3	3	1	1	14	Present study
Peninsula	Nov. 1955	2				1		2	1	1	7	Present study
South	Nov. 1955									4	> 4	Present study
East	Nov. 1955	1	2		1	1		2	2	3	⩾12	Present study
North	Nov. 1955					1			1	2	⩾ 4	Present study

* Infants and juveniles in these censuses were not subdivided, as were those listed below.

SPATIAL DISTRIBUTION, TERRITORY AND HOME RANGE

The members of the laboratory group usually remained 50 to 125 feet above the ground, occasionally coming as low as 15 feet. Howling monkeys were never seen on the ground. Carpenter (1934) and Collias and Southwick (1952) showed that howlers of this species may, on rare occasions, move short distances over ground, and Racenis (1952) presents evidence that the Venezuelan howlers, *Alouatta seniculus*, may frequently do so.

The relative distances between members of the group were not random. Subgroups formed that may indicate the relative frequency of interaction among members. Persistent subgroupings always consisted of associations of adult females with infants and juveniles.

By identification of individuals, it was ascertained that the members in each of these subgroups were unique. The composition of the subgroups of the laboratory group were as follows. Subgroup I consisted of an adult female, and infant$_1$, and a juvenile$_1$. Subgroup II contained an adult female, an infant$_2$, and a juvenile$_2$. Subgroup III contained an adult female, an infant$_3$, and a juvenile$_1$.

Presumably, these subgroups are associations of dams with their offspring, and are the result of the close bond between mother and infant.

Consort pairs, consisting of a male and a receptive female, and play groups are examples of less stable subgroupings whose members always returned to the same basic subgroups.

In vertebrate ecology, "home range" designates the total region within which an animal or group of animals travels. The movements of the laboratory group from October 31 through December 1 (except for November 30) are shown in Fig. 1, which also gives the locations and dates of observations of the adjacent groups. For the laboratory group, this represents roughly 3,374 meters of travel, or an average of 109 meters per day. Carpenter (1934) estimated an average of 200 yards (183 meters) per day during the dry season of 1933.

The center of the group's activities was usually along the eastern slope of Lutz Stream canyon (Fig. 1). While the eastern and northern limits of the group's range were therefore fairly well delimited during the period of study, the remaining boundaries were not clearly defined. The ranges of howling monkey groups overlap (Fig. 1; see also Collias and Southwick, 1952, Map 2, and Carpenter, 1934, Fig. 1).

In the most frequently used parts of the group's range, the large branches that were most often used by the howlers as "pathways" were free of epiphytes. When the group moved through the less frequented parts of the range, epiphytes were broken loose and dropped.

"Territory" designates the portion of the home range that is defended against other members of the same species. Howlers apparently maintain territorial boundaries solely by means of vocal "battles" between members of adjacent groups. Between October 31 and December 1, the laboratory group engaged in five of these territorial battles, the locales of which are shown in Fig. 1. These five battles provide us with only a rough indication of the territorial limits of the group.

When members of two groups detected each other near the edges of their territories, they approached each other rapidly and began vocalizing. The males roared intensely. During each roar, other members of the groups vocalized, though the sound produced by the males was so great that the other members were never heard distinctly. After about 15 minutes, the groups each retreated into their own territories. The roars continued, the males of one group often alternating with those of the other. Sometimes other vocalizations (Types *C* and *E*, described below) were given after the groups had separated.

Although it was never possible to see all of the monkeys during these territorial disputes, there was no indication that physical aggression was ever used.

Adjacent groups apparently never came close to each other without engaging in a territorial conflict; the overlapping of home ranges occurred only when the groups entered the common area at different times.

The organization into quasi-permanent, territorial, closed social groups is characteristic of howling monkeys and of some other primates, but is relatively rare among other orders of vertebrates. These group territories probably entail all the advantages of individual territories (Collias, 1944; Dice, 1952) and in addition make possible types of behavior that require a high degree of social coordination and that depend upon the ability to recognize individuals.

THE DIURNAL CYCLE OF ACTIVITIES

The activities of howling monkeys tend toward a stereotyped sequence. Figure 2 shows the most accurate data that were obtained on the diurnal cycle. Between 6:00 AM and

6:12 PM, the predominant activity of the group was feeding 24.5 per cent of the time, sleeping or playing 51.5 per cent of the time, and progressing 23.9 per cent of the time.

As far as could be determined, the howlers were not active at night. Activity was never seen nor heard after 7:19 PM, and seldom after 6:00 PM. Whenever the howlers were seen at the time they settled down for the night, and again at dawn of the following morning, they were in the same place. During the day, howlers frequently napped. At such times, the infants and juveniles often played, either alone or in groups.

The data that are plotted in Fig. 2 do not include the periods of intense rain. The behavior of the howlers during storms was highly stereotyped. At such times, other activities stopped; the monkeys sat hunched over. The males roared and barked almost continuously during the hardest parts of the storms.

SOCIAL COMMUNICATION

The nature and complexity of social relations in a group are a function of the group's communication system. Analysis of group processes therefore depends upon an understanding of the social signals involved.

Vocalizations are an extremely important part of the communicative system of howling monkeys. An attempt was made to extend our knowledge of these signals, supplementing field notes with sound recordings.

Roar or howl, Type A_1.—The vocalization for which the howling monkeys are best known is a very loud, deep, roaring sound (recorded) that is produced by adult males. These vocalizations undoubtedly correspond with the "type 1" vocalizations of Carpenter (1934).

The enlarged, cup-like hyoid bone of adult male howling monkeys, a unique structure among primates, probably acts as a resonating chamber. Structural variations in the hyoid (Hershkovitz, 1949) may be responsible for some of the individual differences in vocal quality.

This vocalization is produced by the males of each group every day at dawn, and occasionally at other times of the day (Fig. 3). The male of the laboratory group roared every morning of 22 days during the period of this study. Collias and Southwick (1952) reported only two mornings out of 25 in January and February, 1951, during which the

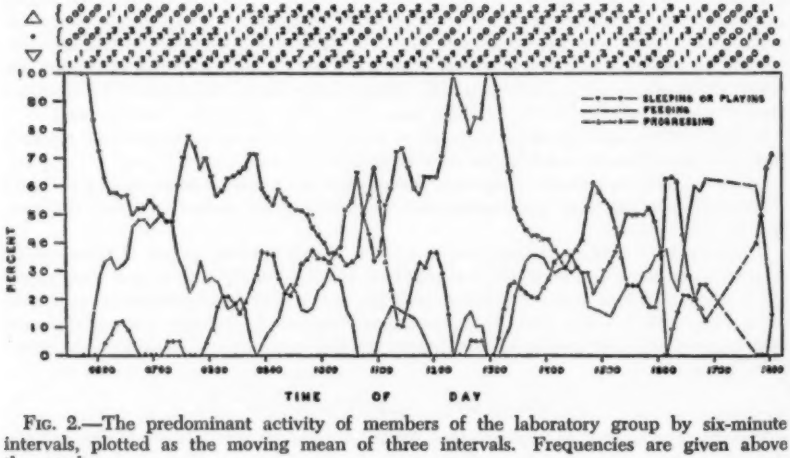

FIG. 2.—The predominant activity of members of the laboratory group by six-minute intervals, plotted as the moving mean of three intervals. Frequencies are given above the graph.

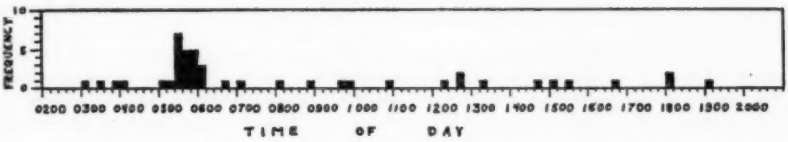

FIG. 3.—The time of onset of howling (vocalization A_1) by the adult male of the laboratory group, October 31 to December 1, 1955.

laboratory group male did not howl. The dawn roaring began between 5:06 and 6:05 AM (mean 5:43), based on data from 22 days, and lasted four to 30 minutes (mean 13.2 minutes), based on data from 15 days.

The morning roar, despite its spectacular auditory aspects, was not accompanied by any comparable burst of physical activity. While giving the vocalization, the male stood on four feet or sat. Occasionally, he fed between roars. Other members of the group gradually became active during the next half hour.

The vocalizations that are given by the males at sunrise are essentially the same as those that are given during territorial disputes, suggesting that these morning howls serve as a "proclamation" of an occupied area. To whatever extent other howlers avoid areas from which such roars come, they function to maintain the territory of the group.

The roar has been observed under several other conditions: heavy rain, thunder, lightning, wind (Carpenter, 1934), firing of a weapon (Lundy, 1954), the sound of airplane motors, attack by a predator (Carpenter, 1934), a fallen young (Carpenter, 1934), and after a midday nap. On several occasions, I have been awakened between 3:00 and 5:15 AM by howls from the laboratory group male during storms on the island or on the mainland.

Incipient roar, Type A_3.—When the stimuli that provoke roaring are mild, a male may give only the gruff, popping preface (recorded) of a complete roar. At times, these pops were very distinct, as though the air were passing over the vocal cords in bursts produced by constricted pharyngeal muscles.

High roar coda, Type A_2.—The roaring sometimes ended on a single sustained note (recorded) that is strikingly high compared with the males' usual timbre. The significance of this vocalization is not known.

Roar accompaniment, Type *B*.—During the height of the male's roar, various other members of the group gave vocalizations (recorded) that seemed to be wailsome in tone. The volume of a male's roar is so much greater, however, that these sounds could not clearly be distinguished.

Male bark, Type C_1.—Adult male howlers produce a type of loud, deep barking (recorded) that has been confused in the literature with roars (Type *A*), both of which are referred to as "howling." The two sounds are easily distinguished, however. Male barking probably corresponds with the "type 9" vocalizations of Carpenter (1934), and with the low, deep-throated "uh, uh, uh, uh" described by Lundy (1954).

The barking vocalization was given by male howlers when disturbed by a human's presence. When barking began, all activities of the group stopped. The members of the group looked in the direction that the male was looking, and in this manner often spotted the source of disturbance. The mother usually carried her infant to a higher limb, then sat, pinning the infant down between her arm and upper thorax.

If I remained silent and motionless, the barking usually stopped after about half an hour, though it sometimes continued for an hour or more. After these barking sessions, the members of the group would, if undisturbed, usually take a nap. A male's last few barks were sometimes given with his eyes half closed, opening at each bark, and closing again between barks. As the intervals between barks became longer, the male fell asleep.

Males sometimes barked after roaring, and a single roar was sometimes given during a barking session.

During strong stimulation and motivation, the barks were loud, deep and evenly spaced. Increased fatigue or decreased stimulation resulted in marked changes. In some cases, the frequency and volume of the barks decreased. The barks often came in groups of two or three with a slight pause between each group. More complex patterns, sometimes including a short "aa" sound made during inhalation, also occurred.

Incipient male bark, Type C_2.—During minimal stimulation or motivation, the barking may be given with the mouth closed. This muffles the tone, so that the vocalization sounds like "unh-aa-unh-aa-unh . . .," including a short vocalization given on the inhalation.

The ability of animals to recognize incipient vocalizations, as well as incipient movements (Tinbergen, 1952), may serve as a source of new social signals. Data on this ability in howlers are lacking.

Female bark, Type D_1.—Adult female howlers produce a barking sound (recorded) that is higher in pitch than that of the males. It is somewhat similar to the barking of a terrier. The vocalization was heard only at times when the group was disturbed by a human. After each burst of barking by a female, the male barked. If he was already barking at the time, his barks increased in frequency and volume.

Incipient female bark, Type D_2.—Like C_2, this vocalization has a muffled tone, and may include inhalation vocalizations. The pitch is higher than that of C_2.

Oodle, Type *E*.—While barking at me or roaring at an adjacent group of howlers, males sometimes interspersed a distinct, complex vocalization that can be roughly transcribed as a very rapid "oodloodloodloodl . . ." (recorded). This series of sounds is given once, usually ascending in pitch.

This vocalization was heard on ten occasions during this study. The only feature that seemed to be common to all of these situations was that they were times of unusually intense disturbance, such as an encounter between adjacent groups. The one time that this vocalization was used by the laboratory group male during a dawn roaring session was on the day after several territorial conflicts with the group to the east.

Eh, Type *F*.—The infant$_1$ of the laboratory group produced a soft, expirant vocalization that I transcribed as "eh!" (recorded). This sound could not be heard beyond about 40 feet. It was repeated every few seconds while the infant clambered in the trees. The mothers did not watch their infants at play, yet upon getting up, would never look around before going directly toward the infants. This vocalization may serve as a locator signal and perhaps also as an indication that the infant is close to the mother and not in distress.

Whimper, Type *G*.—Several other vocalizations were heard, but under such poor observational conditions that I was never sure what was taking place. One of these vocalizations sounded like a high, repeated whimper (recorded). It was heard 20 times during this study. It seemed to be given by immature monkeys in frustrating situations, such as a juvenile$_1$ that was rebuffed by a mother with an infant$_1$ when the juvenile tried to nurse, and a young howler that could not make a crossing during a group progression.

Grunt, Type *H*.—During a group progression, a short, deep, even-pitched vocalization was heard and recorded. Judging by its tone, it is produced by an adult male. This vocalization may correspond with Carpenter's "type 2" (1934).

Cackle-laugh, Type *I*.—On thirteen occasions, I heard a vocalization that resembles a high, staccato, cackling laugh. The "laugh" usually fluctuated over an octave or more and sometimes changed greatly in tone, in a manner that suggested changes in the size of the oral cavity. The function of this vocalization is unknown; it may be the same vocalization that Collias and Southwick (1952) described as "metallic cackling notes," which they observed in an aggressive encounter between two adult females.

Six vocalizations reported by Carpenter (1934:108–109, types 3 through 8) were not heard during the present study. One additional vocalization was reported by Collias and Southwick (1952) that is presumed to maintain vocal contact at dusk. Together with

the 13 vocalizations reported here, these give a total known vocabulary of 20 items for this species.

In addition to vocalizations, there are gestural, olfactory and contact social signals among howling monkeys.

Female howlers sometimes rubbed their genitalia on the surface of large branches. This was done by keeping the front legs in a standing position, bending the hind legs, and moving the rump back and forth in the sagittal plane. An adult male howler was seen sniffing the place on a limb where a female howler had been sitting. A receptive female may place herself so that her rump is near a male, who may smell her genitalia (Carpenter, 1934).

Various gestures, some of which involve body contact, regulate social behavior over relatively short distances. A small infant who is climbing among branches near or above its mother invariably "anticipates" her movement to another place by climbing or dropping down to her body. The infants presumably react to subtle intention movements (Tinbergen, 1952) that I did not detect, despite prolonged observations.

Locomotion by mothers acts as a strong stimulus to the fur-grasping behavior of their infants.

A stereotyped labio-lingual gesture is used by members of consort pairs, but is not inevitably followed by copulation (*cf.* Carpenter, 1934).

SEXUAL BEHAVIOR

Very little sexual behavior was seen during this study. Close, persistent associations of a male and female, which are indicative of sexual receptivity in the female (Carpenter, 1934) were seen in the laboratory group on November 2, 6 and 23, and on December 1. The labio-lingual gesture of a female that serves as a copulatory "invitation" (Carpenter, 1934) was seen on November 6, and again on December 1, but copulation was not seen on either occasion.

A type of behavior that is tentatively classified as masturbation was seen in adult males and females, and in juveniles. The monkey scratched at the genital region for several seconds to a minute, whereupon about two fluid ounces of watery fluid, presumably urine, was emitted (*cf.* Collias and Southwick, 1952). In male monkeys, both adult and juvenile, a slight erection was sometimes noticed after the scratching. Other members of the group did not react to such behavior.

The genital rubbing by adult females that has been described above can probably be considered as masturbation.

MATERNAL BEHAVIOR AND INFANT DEVELOPMENT

Among species of primates that do not form permanent sexual partnerships, the most enduring, close social relation is that between mother and child. Furthermore, a wide variety of evidence from anthropology, ethology, psychology and psychiatry indicates that intraspecific differences in behavior are determined to a greater extent during the earliest stages of life than during subsequent periods. Thus, studies of infant development, particularly of mother–infant relations, are of paramount importance in attempts to understand behavior and social relations. Schneirla (1951) has suggested that differences in early family life may be responsible for the marked contrast between the degree of intragroup aggressiveness in howlers compared with rhesus monkeys, *Macaca mulatta*.

Fortunately, an infant was born in the laboratory group shortly before I arrived. Prolonged observations were made on this infant during the 32 days of this study. Behavioral ontogeny is sufficiently rapid in these primates so that almost daily changes in the infant's behavior and its relations with other members of the group could be detected. The descriptions given below are based primarily upon observations of this infant, supplemented by observations of infants of two other groups.

The exact date of birth of the laboratory group infant is not known, but is estimated to

be October 24, 1955, based upon its size, color, behavior and social relations. I first saw the infant on October 31.

Age 7 through 14 days.—During this period, the infant was always in physical contact with its mother, usually within her ventral flexure. The infant was gray-beige in color. When the female moved from one location to another, the infant rode suspended upside down beneath her, clinging to the fur on her sides with its hands and feet, its head facing the same direction as the dam's. With the infant in this position, the female was able to ascend 50 feet of vertical, unbranched liana with apparent ease.

Whenever the dam stopped and fed herself, the infant began to clamber over her body, showing a tendency to climb upwards on her. It looked at and touched various parts of her body, particularly her face.

When the group was disturbed by my presence, the infant was carried higher into the trees, and then pinned down by the upper arm of the mother, its head protruding toward her back.

At the age of ten days, the infant reached out to a small branch, pulled it, and released it. This, as far as I could tell, was the infant's first manipulation of an object other than parts of its own or its mother's body.

When the infant was 14 days old, it climbed from its mother's lap to the lap of its sibling, a juvenile, which was sitting next to the mother. For two minutes, the infant clambered over the juvenile, then crawled back to its mother. At no time did it lose physical contact with at least one of the howlers.

During this period, the mother and infant were approached several times by other females and their associated infants, who muzzled the infant, presumably trying to play with it. Each time, the mother quickly carried the infant away.

Age 15 through 20 days.—The color of the infant gradually darkened. The first slight change was noticed at age 17 days, particularly on the back of the head and upper shoulders. By 20 days, the infant was definitely gray. At age 15 days, I made a size comparison while the infant sat on the shoulders of the mother. If the infant were rolled up into a ball, it would have been a little less than 1½ times the size of the mother's head, fur included.

As before, the infant began playing whenever the female stopped moving. It showed a tendency to go toward whatever part of her body was uppermost at the time. It continued to crawl about on her body and face. To an ever-increasing extent, however, the infant handled and pulled at various small branches while sitting, or standing on all fours on the dam's back or shoulders. As the pull of the infant became stronger, it lifted itself toward these branches.

At times, the infant pulled itself into the foliage by both arms and legs, keeping only the stiffened tail in contact with its mother's back. When the mother started to move away while the infant was thus out on a limb, it quickly dropped down to her back.

The mother often began locomotion from one feeding place to another within a tree, and sometimes for longer distances, irrespective of the position of the infant at the time, so that the infant was often carried on the mother's back. At such times, it usually rode in the lumbo-sacral region, with its tail coiled around the base of the mother's tail, grasping the fur of her mid-flank. Less often, it rode in the thoraco-lumbar region, holding onto the fur over the scapulae. This dorsal position of the infant was first seen when the infant was about 14 days old, and was common thereafter. As a diagnostic feature of the age category "infants," it should therefore be used with caution.

When 15 days old, the infant passed a landmark in its development. While clambering on branches in the manner described above, it lost physical contact with its mother, twice for 5 seconds, and once for 10 seconds. Each time, it quickly scampered back to her. On subsequent days, the infant spent progressively more of its time climbing on branches, usually maintaining at least tail-contact with its mother. Less time was spent climbing on and exploring the body of its mother. The tendency to stay on top of or above her

was still conspicuous. During these play periods, the female usually ate, but sometimes she dozed. Unless a group progression began, the infant would, after an hour or more of play, return to the ventral flexure of the mother and suckle or sleep.

The tendency of infant howlers to climb upwards is present at birth (Carpenter, 1934) and continues through the first period of infancy. This tendency places the infant in a safer position during its solitary play and enables it to drop quickly to the mother's back when she begins locomotion. Consequently, the infant gradually comes to be carried on the mother's back more frequently than on her belly. The increased weight of the infant makes this a much more efficient method of carrying the child.

Age 21 through 27 days.—The infant's pelt continued to darken; by the end of the study, when the infant was 34 days old, it was dark gray.

The development of locomotor coordination was rapid during this period. The tail was not as prehensile as that of an adult, however. It curled limply around branches, seldom grasping them firmly. The infant used the arms much more, compared with the legs, than does a mature howler. At the age of 26 days, the infant was for the first time seen hanging upside down from a limb, holding on with both hands and both feet. The infant took three "steps" in this position, then lowered itself, arms first, onto its mother's back, a foot below it.

By the age of 23 days, the infant had begun to crawl along the tops of large branches, the usual site of extensive progression by adult howlers.

During its play the infant remained out of contact with the mother for longer periods than previously: 15 seconds to a minute at the age of 23 days. By the age of 26 days, it was returning to the mother every 30 to 60 seconds, but only long enough to crawl over her to branches on the other side. It was spending 95 per cent of its play time in the branches within a foot or two of the mother.

During this period, the infant began to play with other members of the group, who apparently were attracted to the infant. The following incident at the age of 23 days is typical. While the infant's mother dozed, the infant clambered on her and the branches within 3 feet of her. A second female and her associated juvenile, approached the infant. When the infant had climbed onto the back of this female, she and the juvenile moved 10 feet away. For the next 20 minutes, the infant climbed over the two of them and the surrounding branches. At first, the infant crawled unsteadily over the 4 feet of limb separating the juvenile and the female, but the juvenile moved closer to the female and began to lean toward her each time that the infant began to cross. The infant then walked from the head of one to the head of the other. After 20 minutes, the infant's mother came to the group and sat behind the second female. When the infant climbed onto its mother's shoulders, she took it back to where she had been napping.

On subsequent days, the infant was seen crawling back and forth between its mother and its older sibling, a juvenile, who usually sat about 5 feet from the mother during these play periods. By the age of 26 days, the 10 feet to the juvenile and back to the mother were traversed by the infant in about 30 seconds.

Age 28 through 34 days.—During this period of the infant's life, there was further development of the trends indicated previously, namely, increased motor ability, greater independence of the mother, and more frequent interactions with other members of the group.

A description of an incident from the infant's thirty-first day of life will illustrate these trends. The infant climbed from its mother toward its juvenile sibling, 6 feet below. It hung upside down by the tail alone for at least 4 minutes. During this time, it handled foliage, and touched the head of the dozing juvenile. The juvenile awoke and pulled gently on one of the infant's hind legs, which were hanging free, thus swinging the infant toward the juvenile. When the juvenile released its hold, the infant swung back and forth, suspended only by its tail. This "game" was repeated several times.

By the age of 31 days, the infant sometimes wandered as much as 10 feet from the

mother, but usually stayed within 5 feet of her. On that day, for the first time, it was seen eating food other than its mother's milk, namely, young fig leaves.

By the age of 32 days, the infant had begun to move about by itself for short distances during group progressions. When the howlers made a crossing that was too difficult for the infant, the mother carried it on her back, but stopped at the far side while the infant dismounted and proceeded on its own.

Role of the mother.—Reactions of a female howler to her offspring can be described as accommodative or at times proscriptive, but never didactic. She usually tolerates its huddling and suckling, its exploration of her body, and its presence on her back or abdomen. She does very little, however, to stimulate or direct these activities, though she may pick up the infant before moving, or during disturbances of the group. She generally holds the infant during periods of rain, nursing and sleeping.

Young howlers that can move independently are sometimes aided in making a difficult crossing in the trees. The mother may carry the infant across on her back, or make a bridge of her own body (*cf.* Carpenter, 1934; Chapman, 1938).

During times of disturbance, the dams usually ascend to higher places in the trees with their infants clinging to them. There they pin the infants against their bodies with their arms. When infants are very small, they are carried away from other members of the group by the mother. As they begin to attain locomotor independence, the mother does less and less to inhibit social play. As a result of the increased activity of the infant and the fact that infants apparently are an attraction to other members of the society, such play becomes increasingly frequent.

PLAY AND SOCIAL INTEGRATION

Because of their conspicuousness, extensive play activities can occur safely only among animals that are relatively free from predation; because of their energy requirements, such activities are possible only if there is an abundance of food. Thus, the extreme development of play activities in the evolution of primate behavior has been contingent upon the development of adaptations for obtaining food and avoiding predation. To the extent that adaptations for arboreal locomotion in tropical forests have enabled the primates to utilize a relatively untapped food source and to avoid all but a few predators, they have made possible the evolution of the complex and unstereotyped patterns of social behavior that are characteristic of primates and that probably depend, in their ontogeny, upon play behavior. Conversely, the ontogeny of efficient arboreal locomotion probably depends upon play during infancy and childhood. Exploitation of the psycho-biological potentials of arboreal locomotion in tropical forests has thus enabled many primates to enter a new adaptive zone, in the sense of Simpson (1953).

Despite the difficulties in defining "play," there are many readily distinguishable patterns of primate behavior that are treated more conveniently under this rubric than under any other.

Social play occurred at almost all times of the day, but was particularly frequent during the periods from 9:00 to 11:00 AM and from 3:00 to 4:00 PM. While adults fed or rested, infants and juveniles frequently joined together into new subgroups. The play was highly unstereotyped. It generally involved varied patterns of wrestling, chasing, or manipulation of parts of the body. It was always characterized by a high degree of reciprocal interaction.

Since relations with the mother and with playmates are the primary social activities of young howlers, these two types are probably responsible more than any others for the integration of the individual into the society.

DOMINANCE AND AGGRESSION

The aggressive vocal interactions of howlers during territorial conflicts are in marked contrast to the rarity and mildness of intragroup aggressive behavior.

While playing, young howlers sometimes bared their teeth at each other. When the

juvenile, of Subgroup I was rebuffed by its mother while attempting to nurse, the juvenile bared its teeth at its mother. These examples were rare events, however. At no time was any physical aggression seen, nor was there any indication of a dominance hierarchy. Collias and Southwick's report (1952) of an adult male howler biting the tail of an infant in half, then throwing the infant to the ground, is unique.

The relatively short mating provocation time for howling monkeys (*cf.* Chance and Mead, 1953) may account for the low incidence of intragroup aggression. In the absence of sexually receptive famales, the extensive aggressive interaction that is characteristic of rhesus monkeys is absent (Chance, 1956).

INTERSPECIFIC RELATIONS

Most animals of the neotropical forest seemed to be unresponsive to the activities of animals of other species, except for those of species adjacent to them in their food chain. Howling monkeys are no exception. Animals of the following species were observed within clear view and sound of the howlers, without the animals of either species reacting to those of the other: red squirrel (*Sciurus granatensis*), agouti (*Dasyprocta punctata*), crested guan (*Penelope purpurascens*), Giesbrecht's hawk (*Leucopternis albicollis*).

Howlers and capuchin monkeys, *Cebus capuchinus*, were frequently near each other but, for the most part, showed no signs of interaction. On two occasions, howlers and capuchins were observed progressing in mixed groups. In one case, a capuchin approached to within 5 feet of a howler mother and her infant. The female gave a rapid, gruff vocalization, and the capuchin went away.

The feces of howlers were an attraction to swarms of iridescent green dung beetles, which cut the fecal matter into balls about the size of peas, roughly twice the volume of their own bodies. Within 10 minutes after the feces dropped, about half of their mass had been cut up and rolled away by the beetles.

The howlers appeared to be heavily infected with ectoparasites. Grooming behavior, a common phenomenon among catarrhine monkeys, was never seen in the howlers, though they frequently brushed insects away with a paw or tail. With the exception of the infant, all of the members of the laboratory group had large subcutaneous swellings, caused, presumably, by botfly larvae. Most of these swellings were on the ventral surface of the neck, but occurred on other parts of the body as well.

ACKNOWLEDGMENTS

The field recorder that was used in this study was provided by the Division of Neuropsychiatry, Walter Reed Army Institute of Research, through the courtesy of its director, David McK. Rioch. Much information on field recording was provided by Peter P. Kellogg. C. Ray Carpenter and Nicholas E. Collias made valuable suggestions on field techniques; they and Edward O. Wilson critically read and commented on the manuscript of this paper. To all of these people, I am deeply grateful.

SUMMARY

An observational study was made of the ecology, behavior and social relations of howling monkeys, *Alouatta palliata*, on Barro Colorado Island, Panama Canal Zone, during the rainy season of 1955.

Extensive observations were made on a single group, consisting of 3 infants, 6 juveniles, 4 adult females and 1 adult male. The group lived in an area of mature tropical forest.

The howlers fed on a wide variety of fruits, nuts and leaves, but figs and fig leaves predominated in their diet. Feeding involved neither competition nor cooperation.

Groups of howling monkeys defended a territory within their home ranges against intrusion by other members of the same species. The territories were maintained primarily by means of loud, deep roaring vocalizations given by the adult males. Ten vocalizations

are described for the first time, bringing the total known vocabulary of this species to 20 distinct vocalizations. Gestural, olfactory and contact stimuli also are important in social communication.

The daily activities of the howlers showed a tendency toward a stereotyped pattern.

With the exception of territorial defense, little aggressive behavior was seen. Masturbation, labio-lingual copulatory gestures, and consort pairs were seen, but copulation was not.

A detailed study was made of the maturation of an infant howler from the seventh to the thirty-fourth day of life. The primary trends were toward increased physical coordination, decreased dependence upon the mother, and increased social intraction. The purview of the infant howler enlarges primarily as the result of its own activities. In a sense, it is an autodidact: its mother does nothing specific to stimulate and little to inhibit its behavior. Its integration into the society depends, therefore, upon the mutual attractions between it and other members of the group.

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THE RELATIONSHIPS OF TWO SUBSPECIES OF POCKET GOPHER IN CENTRAL NEW MEXICO

By James L. Sands and James S. Findley

Pocket gophers of the species *Thomomys bottae* (Eydoux and Gervais) inhabiting the valley of the Rio Grande in the vicinity of Albuquerque, New Mexico, are characterized by large size and pale, sandy coloration. These animals inhabit deep, sandy, light-colored alluvial soils. The local population with these traits has been accorded subspecific designation under the name *Thomomys bottae connectens* Hall. Gophers inhabiting the Sandia and Manzano mountains just east of the Rio Grande valley in central New Mexico are characterized by small size and dark, reddish coloration. These animals inhabit montane forests in dark soils of shallow to medium depth. These small dark gophers have long been known as *Thomomys fulvus* (Woodhouse). The work of Goldman (1931: 416) and Hall (1932: 325) has shown *T. fulvus, T. perpallidus* and *T. bottae* to be conspecific. Hence the Sandia and Manzano animals are now known as *T. bottae.* Kelson (1951) has recognized gophers from the Sandias and Manzanos as a distinct subspecies, *T. b. actuosus* Kelson. In his treatment of *Thomomys bottae* in New Mexico, Kelson (*op. cit.*) indicated the existence of a hiatus between the geographic ranges of *T. b. actuosus* and *T. b. connectens.*

In view of the trenchant differences between *T. b. actuosus* and *T. b. connectens,* in view of Kelson's implication that the ranges of these two kinds do not meet, and in view of the fact that some workers (*e.g.,* Hooper, 1940) have hesitated to accept the conspecific status of *fulvus* and *bottae,* an investigation of the relationships between *connectens* and *actuosus* was undertaken.

The area in which the geographic ranges of *T. b. actuosus* and *T. b. connectens* approach one another, and which we deemed the best one for testing the relationships of these two kinds, is located in eastern Bernalillo County, New Mexico, between the city of Albuquerque in the Rio Grande valley, and the Sandia Mountains, approximately 12 miles east of Albuquerque (Fig. 1). In this distance there is an increase in altitude of over 5,000 feet from the valley to the crest of the mountains at 10,678 feet. Between the valley and the foothills of the mountains is a broad, gently sloping piedmont, locally known as the mesa. From the eastern edge of the mesa, the western slope of the mountains rises steeply, in some places precipitously, to the crest of the range.

The valley is vegetated with cottonwood forest, in many places broken with cultivated fields and human dwelling sites. In the valley pocket gophers are relatively common. The mesa was originally covered with mixed prairie but, owing to overgrazing, this area is now sparsely covered with grass, Russian thistle, yucca and cane cactus. Across the mesa run many small arroyos in which the soil is loose and sandy or gravelly. These arroyos often support stands of rabbit bush and apache plume. On the mesa, gophers are

exceedingly rare and difficult to locate. Those that do live here are usually found in or on the edges of the arroyos. The lower foothills of the western slope of the Sandias support a community of evergreen oak, beargrass, pinyon, juniper, apache plume and mountain mahogany on a thin rocky soil. Here gophers are rare. Higher up are found zones of yellow pine and then spruce and fir. In these higher forests gophers are often abundant.

Our field investigations have revealed no hiatus between the ranges of the valley and mountain forms of *Thomomys* in this area, but only an interval, the mesa and lower foothills, where gophers are uncommon.

We have examined 78 gophers referable to *T. b. actuosus* from the Sandia Mountains and 50 specimens referable to *T. b. connectens* from the Rio Grande valley. From this examination we perceive *T. b. actuosus* to differ from *T. b. connectens* as follows. *Thomomys b. actuosus* is much smaller than *T. b. connectens*. So well marked is this difference that in some measurements the largest *actuosus* falls far short of the smallest *connectens*. Most cranial measurements in these animals are positively correlated with condylobasal length;

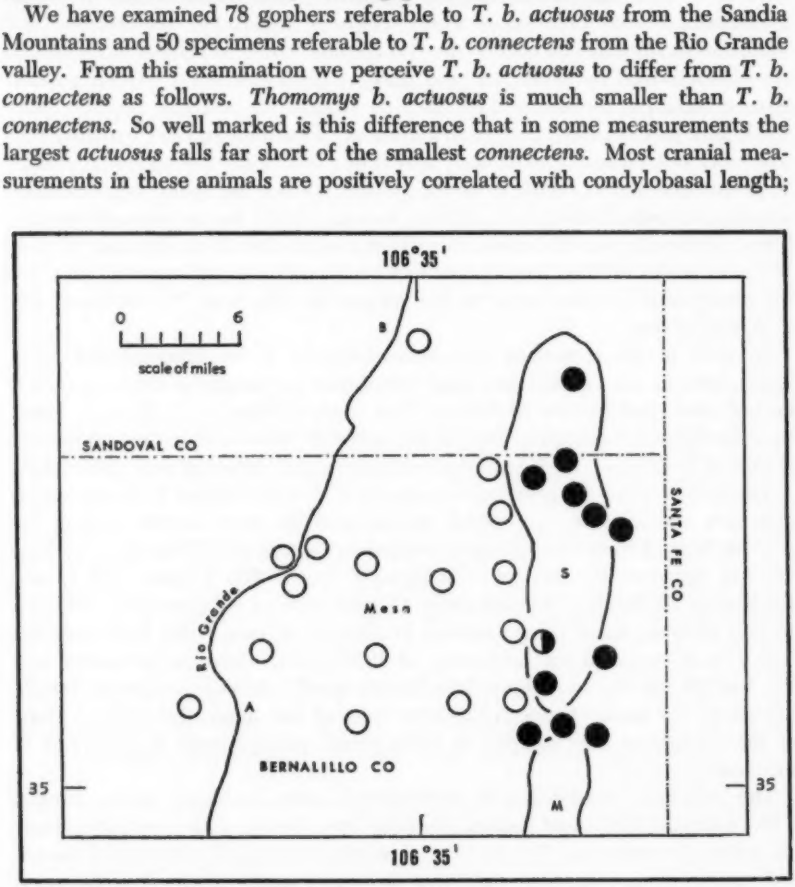

FIG. 1.—Map of northeastern Bernalillo Co., New Mexico, showing localities from which gophers were obtained. Open circles indicate *T. b. connectens*, solid circles *T. b. actuosus*, half-open circle intermediate population. Albuquerque, Bernalillo, Sandia Mountains, and Manzano Mountains are indicated by the letters *A*, *B*, *S* and *M*, respectively.

hence, we have used the latter measurement in Fig. 2 as an index of cranial size. A few cranial measurements are not positively correlated with condylobasal length. For example, the maximum interorbital breadth is attained by these gophers early in life, and thereafter increases very slowly or not at all. Hence, *actuosus* has a relatively greater interorbital breadth than does *connectens*. Expressed as a percentage of condylobasal length, the interorbital breadth of 29 female *actuosus* averages 18.1 per cent, compared to 16.4 per cent for 26 female *connectens*. In our comparisons of size and cranial configuration we have used only female gophers, since many more than males were obtained. The skull of *actuosus* is less robust and angular than that of *connectens*, the crests are less pronounced, the zygomatic plate of the squamosal extends over the auditory tube, and the incisors are shorter. In color, *T. b. actuosus* is darker than *T. b. connectens*. The upper parts are more Ochraceous than yellowish (capitalized color terms refer to those of Maerz and Paul, 1930; terms in italics are those of Ridgway, 1912); the underparts are *cinnamon* rather than white, and the tail is more distinctly bicolored, often with a distinct white tip. In *connectens*, a fairly well-defined dark mid-dorsal stripe is evident. This stripe is poorly defined or, more commonly, completely absent in *actuosus*. In an attempt to quantify our observations on color in these animals we have used the method employed by Anderson (1956) in his study of geographic variation in western populations of *Microtus pennsylvanicus*. We selected a typical specimen of *T. b. actuosus* and arbitrarily assigned it the number 2. We then selected a typical *connectens* and assigned it the number 4. Then each other specimen was compared with these two standards. If the individual was more reddish than the standard "2," it was assigned the number 1. If it was more

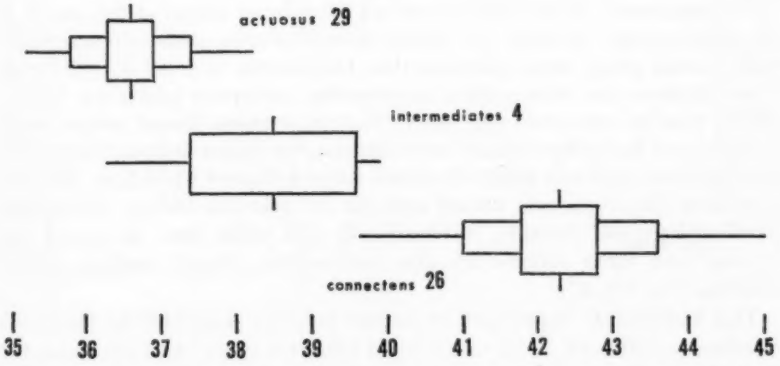

FIG. 2.—Condylobasal length of three populations of *Thomomys bottae*. Horizontal line indicates extremes, vertical line mean, center rectangle extends two standard errors on each side of the mean, outer rectangle extends one standard deviation on each side of the mean. For the intermediate population only standard errors are shown. Numbers after names indicate number in sample. Scale is in millimeters.

yellowish than "2" but not so yellowish as "4," it was assigned the number 3. If the specimen was paler yellow than "4" it was assigned the number 5. Of course, if the specimen was most like either of the standards it was assigned the same number as the appropriate standard. Treated in this way, the color differences between *connectens* and *actuosus* are strikingly evident. The mountain form has an average color designation of 1.9, and the valley form an average of 4.0. All of the mountain specimens rate 1 or 2; the valley specimens range from 3 to 5. So great are these size and color differences that, if we had available only specimens from the valley and from the mountains for comparison, we would feel no hesitancy in regarding the two populations as representatives of distinct species.

Specimens which we have obtained from the mesa and lower foothills, while few in number, form an interesting and highly critical part of the problem. Those specimens obtained on the mesa are identical to typical *connectens* in color, but average slightly smaller in size. The smaller size, we think, is a reflection of the shallower and tighter soil on this area. We have taken a number of these slightly smaller *connectens*-like animals at the very base of the mountains.

Specimens obtained in the western foothills of the Sandia Mountains are like *T. b. actuosus* in every way. We have taken one such specimen at the base of the foothills at an elevation and in an ecological situation similar to those at which specimens of *T. b. connectens* have been taken by us. In the face of these data, it seems that the ranges of the two kinds abut and that individuals of the two forms do not crossbreed.

However, at a point 9 miles east and 3½ miles north of Albuquerque, at the western base of the Sandia foothills, we obtained five specimens which seem to us to be intermediate as a population between *T. b. actuosus* and *T. b. connectens*. These animals were all taken in an arroyo at the mouth of the same canyon. In color, one animal resembles *connectens* in nearly white belly, dorsal pelage more yellowish than Ochraceous, and tail not bicolored. Two specimens are intermediate in possessing underparts which are Tawny, darker than in *connectens*, but lighter than in *actuosus*, dorsal pelage which is darker and less yellowish than in *connectens*, but lighter and not Ochraceous as in *actuosus*, and tails faintly bicolored without distinct white tips. The two remaining specimens tend toward *actuosus* in Tawny to Diffuse Ochraceous dorsal pelage, and distinctly bicolored tails with white tips. In cranial and external size these animals are also intermediate though tending toward *actuosus* (see Fig. 3).

This intermediate population, as pointed out, was occupying an ecological situation no different, so far as we could tell, from other situations along the foothills which support populations of both typical *actuosus* and typical *connectens*. We therefore do not think that this is a case of an intermediate habitat producing intermediate animals. We think instead that this population arose as a result of crossbreeding between *T. b. actuosus* and *T. b. connectens*.

We have detected no zone of intergradation between the two kinds, not even a narrow zone, but instead only a small colony of intermediates with typical examples of each parent stock close at hand. It may well be that the rarity of gophers of either kind in the mesa and foothill zone makes the chances of crossing between the two very small. Even so, occasional crosses, with resultant introgression of genes from the population of *T. b. actuosus* into that of *T. b. connectens* and vice versa, should produce a more gradual intergradation of characters than that detected by us. It may be that for one reason or another animals of one kind do not always mate with those of the other kind, even when the opportunity presents itself, or that contact between the two kinds is of such recent origin that a zone of intergradation has not had time to develop.

We interpret the relationship of the two kinds of gophers being dealt with as an example of secondary intergradation as the term is used by Mayr (1942). This implies that the two kinds have been geographically separated at some time in the past and have since established contact. What the barrier may have been which caused this separation is not immediately obvious. At present the Sandia Mountains afford favorable habitat for gophers. The mesa between the Rio Grande and the mountains harbors few gophers now, but it seems likely that in the past, before overgrazing and erosion had so affected it, it may have been a more favorable place. Another possibility occurs to us.

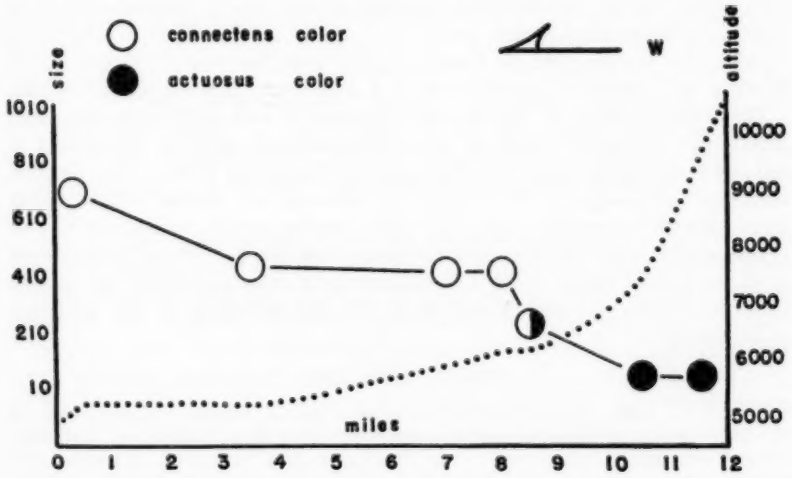

FIG. 3.—Relationship of size and color in *Thomomys bottae* to altitude and geographic position. The broken line represents altitude profile. Albuquerque lies at the left and the crest of the Sandia range to the right of the diagram. Solid line represents size of gophers. Numbers on left margin indicate a size index based on a number of cranial and external measurements treated by the method of Hubbs, Hubbs and Johnson (1943). Larger numbers indicate larger gophers.

Several of the higher mountain masses in northern New Mexico, such as the Sangre de Cristo, Jemez, San Juan and Chuska Mountains and Mount Taylor, are inhabited by the northern pocket gopher, *Thomomys talpoides*. In the higher parts of these ranges, where *T. talpoides* occurs, *T. bottae* is absent. Seemingly populations of the former act as a biological barrier to those of the latter. *Thomomys talpoides* is not known to occur in the Sandia Mountains, but it may have done so in the past. This possibility is suggested by the presence, in the spruce-fir zone of the Sandias, of typical boreal associates of *T. talpoides* such as *Eutamias minimus, Tamiasciurus hudsonicus, Microtus longicaudus* and *Sorex vagrans*. A corridor of continuous spruce-fir, or at least yellow pine, forest extending from the Sangre de Cristo or Jemez Mountains to the Sandias would be required to afford an entryway for these animals. It seems likely that *T. talpoides* would have followed this same corridor. The absence of *T. talpoides* in the Sandias at present (as well as the absence of certain other boreal mammals such as *Marmota flaviventris, Citellus lateralis, Lepus americanus* and *Neotoma cinerea*) may be explained by the past occurrence of extreme drought conditions such as the Altithermal interval following Wisconsinan glaciation. Such an event may have resulted in the extinction of certain boreal forms in the Sandias, including *T. talpoides*. At any rate, if the northern pocket gopher once occurred in the Sandias, it would in all likelihood have acted as a biological barrier to *T. bottae*, dividing the latter into isolated populations on the eastern and western sides of the mountains. This barrier would have vanished sometime during the Altithermal, or perhaps four to six thousand years ago. Since that time, the small reddish *T. b. actuosus* invaded the higher montane forests, spilled over the western slopes of the Sandias, and established contact with *T. b. connectens* in the western foothills.

Whatever the case, we feel that the distribution and variation pattern seen here is not attributable solely to local differentiation owing to differences in soil color and depth which is often seen in *Thomomys bottae*. We also feel that, since all subspecies of *T. bottae* are obviously not equally differentiated from adjacent subspecies, some (as here) having nearly achieved a degree of distinctness which usually characterizes full species, the present arrangement of all geographic forms of the *T. bottae* complex as subspecies of one species tends to obscure features important to an understanding of the evolution of the group.

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NOMENCLATURE AND TAXONOMY OF THE NEOTROPICAL MAMMALS DESCRIBED BY OLFERS, 1818

BY PHILIP HERSHKOVITZ

An infrequently cited and rarely consulted systematic work on Neotropical mammals by Ignatz von Olfers (1793–1872) forms the 10th Chapter of a book by Wilhelm Ludwig Eschwege. The book bears the title "JOURNAL/VON/ BRASILIEN,/ oder/vermischte Nachrichten aus Brasilien, auf/wissenschaftlichen Reisen gesammelt." It was published in 1818 as volume 15 (Heft 2) of the "Neue Bibliothek/ der wichtigsten/ Reisebeschreibungen/zur/Erweiterung der Erd- und/Volkerkunde;/in Verbindung/mit einigen anderen Gelehrten gesammelt/und/herausgegeben/von/ Dr. F. T. Bertuch . . .", Weimar. A set of this work is housed in the Library of Congress, another in the Harvard College Library.

The chapter written by Olfers accounts for practically all the South American mammals known to that author. The actual specimens examined, some of them collected by Olfers himself, were and possibly still are preserved in the Berlin Museum. The technical names and classification of the animals used by Olfers were taken from Illiger's "Ueberblick der Säugthiere nach ihrer Verteilung über die Welttheile." This treatise, read on 28 February 1811 at the Berlin Academy of Science, did not appear in print until 1815, two years after its author's death. Illiger's contribution to mammalian zoogeography, one of the earliest based on the Linnaean system of nomenclature, lists many names he had written on labels of undescribed specimens in the Berlin Zoological Museum. The majority of Illiger's manuscript names, or *nomina nuda*, for South American mammals were validated in 1818 by Olfers. The same names were also cited by other authors, notably Lichtenstein, Kuhl, Wied-Neuwied, Brants, Wagner and Temminck, who examined and described the types in the Berlin Museum.

Olfers' descriptions, however, take precedence for nomenclatorial purposes in every case.

The following analyses are arranged in two parts. Section I lists all new names in the form and order proposed by Olfers, 1818, together with their modern equivalents, if any. Section II deals with those names which have complicated synonymies or whose systematic positions require clarification.

This work is a contribution to the Check List of South American Mammals being prepared for publication by the author.

SECTION I

P[ithecia] nocturna (p. 198) = *Pithecia pithecia* Linnaeus 1766 (Syst. Nat., ed. 12, 1: 40).—This name, with authorship attributed to Illiger, together with *adusta* (see below), the *singe de nuit* of Buffon, and *S. pithecia* Audebert are cited in the synonymy of *Pithecia rufiventris* Geoffroy.

P[ithecia] adusta (p. 198) = *Pithecia pithecia* Linnaeus, 1766 (Syst. Nat., ed. 12, 1: 40).—Illiger's manuscript name *adusta* for a specimen in the Berlin Museum is used by Olfers as a synonym of *pithecia* Linnaeus.

P[ithecia] Stenorrhina (p. 198) = *Aotus trivirgatus azarae* Humboldt, 1812 (Rec. Obs. Zool. Anat. Comp., 1: 359).—Illiger's *nomen nudum P. Stenorrhina* is identified with "*P. Miriguouina* [sic = *miriquouina* Geoffroy, 1812]" which is based on the *miriquouina* of Azara (1801, 2: 243).

Actuo [sic] (p. 199) = *Aotus* Illiger, 1811 (Prodr. Syst. Mamm. Av., p. 7).—*Actuo* is a typographical error or a *lapsus calami* for *Aotus*.

C[ebus] Çay (p. 199) = *Cebus apella cay* Illiger, 1815 (Abh. Akad. Wiss. Berlin, 1804–1811: 107 (name), 111 (*cay* Azara).

C[ebus] hypokantha (p. 201) = *Callicebus moloch* Hoffmannsegg, 1807 (Mag. Gesellsch. Naturf. Fr. Berlin, 1: 97).—Illiger's *nomen nudum* is cited by Olfers in the synonymy of *C. moloch*.

C[ebus] infulata (p. 201) = *Aotus trivirgatus trivirgatus* Humboldt, 1805 (Rec. Obs. Zool. Anat. Comp., 1: 408).—The type, from Brazil, is in the Berlin Museum. The same specimen was re-described in 1820 by Kuhl (Beitr. Zool., p. 38) as *Callithrix infulatus* with the name attributed to Lichtenstein.

C[ebus] villosa (p. 201) = *Aotus trivirgatus trivirgatus* Humboldt, 1812 (Rec. Obs. Zool. Anat. Comp., 1: 408).

D[idelphys] frenata (p. 204) = *Philander opossum frenata* Olfers, 1818 [see page 342 below].

[Didelphys superciliaris] (p. 204) = *Philander opossum frenata* Olfers, 1818 [see page 342 below].

D[idelphys] macrura (p. 205) = *Marmosa pusilla* Desmarest, 1804 [see page 343 below].

D[idelphys] brevicaudis (p. 205) = *Monodelphis brevicaudis* Olfers, 1818 [see page 344 below].

D[idelphys] lanata (p. 206) = *Caluromys lanatus lanatus* Olfers, 1818 [see page 345 below].

D[idelphys] crassicaudis [sic] (p. 206) = *Lutreolina crassicaudatus* Desmarest, 1804.—Olfers cited "*D. crassicaudata* Desm. dict[ionnaire d' histoire naturelle, 24: 19, 1804]" and the "*micouré à queue grosse* Az[ara] 1, p. 284" in synonymy. Thus the name *crassicaudis* Olfers is clearly an invalid emendation of *crassicaudata* Desmarest.

D[idelphys] nana (p. 206) = *Marmosa pusilla* Desmarest, 1804 [see page 343 below].

D[idelphys] tristriata (p. 206) = *Monodelphis americanus* Müller, 1776, (Linnaeus Syst. Nat., Suppl., p. 36).—Both names are based on the Brazilian *Mus araneus* of Marcgrave (1648, Hist. rerum Nat. Brasil., p. 229). This is the *Sorex brasiliensis* of most authors.

Ch[ironectes] variegatus (p. 206) = *Chironectes minimus minimus* Zimmermann, 1780 (Geogr. Geschichte, 2: 317).—Olfer's *variegatus* is merely a substitute name for *minimus* Zimmermann.

[Meriones] apicalis (p. 207) = [?] *Hydromys chrysogaster* E. Geoffroy, 1804 (Bull. Soc. Philom., Paris, 3: 354 [misprinted 254]).—According to Olfers, *apicalis* is from Brazil, not the Moluccas as labeled by Illiger (1815, p. 56). Kuhl (1820, Beitr. Zool., p. 70) also described the same specimen in the Berlin Museum but gave "India orientale" as the habitat. Modern authors follow Trouessart (1897, Cat. Mamm., p. 458) in treating *apicalis* as a synonym of *Hydromys chrysogaster* E. Geoffroy.

M[eriones] musculus (p. 207) = [?] *Calomys laucha laucha* Olfers, 1818.—See *Mus laucha* Olfers (p. 339).

? **Sc[iurus] lineatus** (p. 207) = a *nomen nudum*, attributed to Illiger.

Sc[iurus] Grenatensis (p. 208) = a *nomen nudum*, attributed to "Zimm[ermann?]."

Sc[iurus] olivascens (p. 208) = *Sciurillus guajanensis* Kerr, 1792 [see page 345 below].

Sc[iurus] spadiceus (p. 208) = *Sciurus spadiceus* Olfers, 1818 [see page 346 below].

A[rctomys] Viscauia [sic] (p. 208) = *Lagidium viscacia viscacia* Molina, 1782 (Sagg. Stor. Nat. Chili, p. 307).—Olfers cites Molina, hence *viscauia* is obviously a misspelling of *viscacia*.

M[us] Mexicanus (p. 209) = a *nomen nudum*.

M[us] capito (p. 209) = *Oryzomys capito* Olfers, 1818.—This antedates *Mus cephalotes* Desmarest, 1819 (Nouv. Dict. Hist. Nat., 29: 63) which, like *capito* Olfers, is based solely on the *Rat à grosse tête* of Azara (1801, 2:82). *Oryzomys laticeps* Lund, 1841, appears to be the same species.

M[us] buccinatus (p. 209) = *Oryzomys buccinatus* Olfers, 1818 [see page 347 below].

M[us] physodes (p. 209) = *Reithrodon physodes* Olfers, 1818 [see page 348 below].—Antedates *Mus auritus* Desmarest, 1819.

M[us] rutilans (p. 209) = *Oxymycteris rutilans* Olfers, 1818.—Antedates *Mus rufus* Desmarest, 1819 (Nouv. Dict. Hist. Nat., 29: 62) which, like *rutilans*, is based solely on the *rat roux* of Azara (1801, 2: 94). *Mus nasutus* Waterhouse, 1837, is a synonym.

M[us] nigripes (p. 209) = *Oryzomys nigripes* Olfers, 1818.—The name is based on the *rat à tarse noir* of Azara (1801, 2: 98) and antedates *nigripes* Desmarest, 1819, based on the same. *Mus longicaudatus* Bennett, 1832, is not more than subspecifically distinct and may be cited as *Oryzomys nigripes longicaudatus*.

M[us] Laucha (p. 209) = *Calomys laucha laucha* Olfers, 1818.—Based on the *laucha* of Azara (1801, 2:102) Olfers' name antedates *Mus laucha* Desmarest, 1819. The generic name *Calomys* Waterhouse, 1837, with type *Mus bimaculatus* Waterhouse [=*laucha* Olfers] has priority over *Hesperomys* Waterhouse, 1839, with the same type species.

H[ystrix] nycthemera (p. 211) = *Coendou prehensilis prehensilis* Linnaeus, 1758 (Syst. Nat., ed. 12, 1: 57).—The description is based on a Brazilian prehensile-tailed porcupine preserved in the Berlin Museum.

H[ystrix] pollicaris (p. 211) = *Coendou prehensilis prehensilis* Linnaeus, 1758 (Syst. Nat., ed. 12, 1: 57).—Illiger's manuscript name is listed in the synonymy of *H. nycthemera* as possibly a variety.

H[ystrix] tortilis (p. 211) = *Chaetomys subspinosus* Olfers, 1818 [see page 349 below].

H[ystrix] rutila (p. 211) = *Chaetomys subspinosus* Olfers, 1818 [see page 349 below].

H[ystrix] insidiosa (p. 211) = *Coendou insidiosus* Olfers, 1818.—Antedates *Coendou insidiosus* Kuhl, 1820 (Beitr. Zool., p. 71), based on the same specimen in the Berlin Museum.

H[ystrix] volubilis (p. 212) = *Chaetomys subspinosus* Olfers, 1818 [see page 349 below].

Loncheris [sic] (p. 212) = *Loncheres* [= *Echimys* Cuvier, 1809] Illiger, 1811 (Prodr. Syst. Mamm. Av., p. 90).

L[oncheris] paleacea (p. 212) = *Echimys paleacea* Illiger, 1811 (Prodr. Syst. Mamm. Av., p. 90).—Antedates *Loncheres paleacea* Lichtenstein, 1820 (Abh. Akad. Wiss. Berlin, 1818–1819: 191, pl. 1, fig. 1) and Kuhl, 1820 (Beitr. Zool., p. 72). These authors merely

redescribed Illiger's type specimen in the Berlin Museum. The original description of *paleacea* Illiger, 1811, is contained in the diagnosis of the genus *Loncheres* Illiger (loc. cit.).

L[oncheris] brachyura (p. 212) = *Euryzygomatomys spinosus* Desmarest, 1817 (Nouv. Dict. Hist. Nat., 10: 57).—The names proposed by Olfers and Desmarest are based on the *rat premier, ou rat épineux* of Azara (1801, 2: 73) and the *echimys roux* of Cuvier (1817, Regn. Anim., 1: 195). Paraguay is the type locality for all the above.

"L[epus] minimus Mol. L. (Gm.)," (p. 213) = *Cavia porcellus* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 59).—The Chilean *cuy*, or domestic guinea pig, was described as *L. minimus* by Molina, 1782 (Saggio sulla storia naturelle del Chili, lib. 4: 306). The name is valid and the animal perfectly identifiable from the description in spite of some gross inaccuracies in the characterization.

D[asyprocta] moschata (p. 214) = *Dasyprocta aguti fulvus* Kerr, 1792 [see page 349 below].

D[asyprocta] Patagonum (p. 214) = *Dolichotis patagonum patagonum* Zimmermann, 1780 (Geogr. Geschichte, p. 328).—Olfers' *patagonum* is based primarily on the Patagonian Cavy of Pennant with the *Lievre pampa* of Azara (1801, 2: 51) in synonymy.

T[atus] grandis (p. 219) = *Priodontes maximus* Kerr, 1792 [see page 350 below].

T[atus] decumanus (p. 219) = a *nomen nudum* attributed to Illiger.

T[atus] gilvipes (p. 220) = *Euphractus sexcinctus flavimanus* Desmarest, 1804 (Nouv. Dict. Hist. Nat., 24: Tableau 28).—Olfers' *gilvipes* is based solely on the *tatou poyou* of Azara (1801, 2: 142). Illiger's prior (1815: 108) use of *gilvipes* is as a *nomen nudum*.

T[atus] gymnurus (p. 220) = *Cabassous unicinctus* Linneaus, 1758 (Syst. Nat., ed. 10, 1: 50).—The *tatou tatouay* of Azara (1801, 2: 155), is Olfers' basis for *gymnurus*. This technical name is a *nomen nudum* in Illiger's work (1815: 108).

T[atus] villosus (p. 220) = *Chaetophractus villosus* Desmarest, 1804 (Dict. Hist. Nat., Paris, 24: Tabl., 28).—Both Olfers and Desmarest based this name on the *tatou velu* of Azara (1801, 2: 164).

T[atus] fimbriatus (p. 220) = *Zaedyus pichiy* Desmarest, 1804 (Dict. Hist. Nat., Paris, 24: Tabl., 28).—The names proposed by Olfers and Desmarest are based solely on the *tatou pichiy* of Azara (1801, 2: 192). Illiger's (1815: 108) *fimbriatus* is a *nomen nudum*.

D[asypus] pilosus (p. 220) = a *nomen nudum*.

T[atus] auritus (p. 221) = *Dasypus septemcinctus* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 54).—Olfers' *auritus* is based solely on the *tatou mulet* of Azara (1801, 2: 186). Illiger's *auritus* (1815: 108) is a *nomen nudum*.

Tolypeutis (p. 221) = *Tolypeutes* Illiger, 1811 (Prodr. Syst. Mamm. Av., p. 111).

T[olypeutis] globulus (p. 221) = *Tolypeutes tricinctus* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 51).

Ph[yllostomus] spiculatus (p. 224) = *Sturnira lilium lilium* E. Geoffroy, 1810 (Ann. Mus. Hist. Nat., Paris, 14: 181).—The names are based on the *chauve-souris quatrieme ou chauve-souris brun-rougeatre* of Azara (1801, 2: 277).

Ph[yllostomus] lineatus (p. 224) = *Vampyrops lineatus* E. Geoffroy, 1810 (Ann. Mus. Hist. Nat., Paris, 15: 180).—The synonyms are based on the *chauve-souris seconde ou chauve-souris brune et rayée* of Azara (1801, 2: 271).

Ph[yllostomus] lituratus (p. 224) = *Artibeus lituratus lituratus* Olfers, 1818.

Ph[yllostomus] frenatus (p. 224) = *Artibeus lituratus lituratus* Olfers, 1818.—The type is a specimen in the Berlin Museum. Its description follows: *"folio nasali basi rotundato, lanceolato trisulcato; pallide brunneus, abdomine albido, striis a rostro ad aures excurrentibus utrinque* 2. Lat. exp. 2–3" [i.e., wing spread, 2 feet, 3 inches]." This characterization can aply only to *Artibeus liuratus* although *"abdomine albido"* is not the usual condition in the species.

N[octilo] ? rufescens (p. 225) = *Noctilio leporinus rufescens* Olfers, 1818.—The name *rufescens* Olfers based on the Paraguayan *chauve-souris rougeâtre* of Azara (1801, 2: 280)

takes priority over *Noctilio rufipes* d'Orbigny, 1836 (Voy. Amérique Mérid., Mamm., pl. 9, figs. 1–4) from Río San Miguel, Guarayos, Bolivia.

E[rinaceus] inauris (p. 226) = a *nomen nudum*.—Said to be from South America where hedgehogs do not occur.

[Cercoleptes] lepidus (p. 227) = *Potos flavus prehensilis* Kerr, 1792 [see page 350 below].

N[asua] Mondé (p. 227) = *Nasua nasua nasua* Linnaeus, 1766 [see page 351 below].

N[asua] obfuscata (p. 227) = *Nasua nasua nasua* Linnaeus, 1766 [see page 351 below].

N[asua] minor (p. 227) = *Nasua nasua nasua* Linnaeus, 1766 [see page 351 below].—This Illiger manuscript name is cited in the synonymy of *N. obfuscata*.

N[asua] spadicea (p. 227) = *Nasua nasua spadicea* Olfers, 1818 [see page 352 below].

N[asua] Squash? (p. 228) = a *nomen nudum*.

N[asua] ? canina (p. 228) = *Procyon cancrivorus cancrivorus* Brongniart, 1792 [see page 352 below].—The bibliographic reference for Olfers' *canina* is "*Koupara* Zimm[ermann]" from Spanish America.

G[ulo] canescens (p. 229) = *Eira barbara barbara* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 46).—*Gulo canescens* was proposed by Illiger, 1815 (Abh. Akad. Wiss. Berlin, 1804–1811: 109) as a substitute name for *Mustela barbara* Linnaeus.

G[ulo]? suffocans (p. 229) = *Conepatus chinga suffocans* Illiger, 1815 (Abh. Akad. Wiss. Berlin, 1804–1811: 109, 121).—Illiger based the name *suffocans* solely on Azara's *yaguare*, the Paraguayan skunk.

All skunks of the genus *Conepatus* appear to be conspecific. The earliest name for a member of this genus is *Viverra chinga* Molina, 1782 (Saggio Stor. Nat. Chili, p. 288).

C[anis] gibbosus (p. 229) = *Canis familiaris* Linnaeus, 1758 (Syst. Nat. ed. 10, 1: 38).—The name is based on the "*Itzcuintepotzoli*" of Humboldt which, in turn, refers to the Mexican hunchback dog, the "*Ytzcuinteporzotli*" of Hernández (1651, Rerum medicarum Novae Hispaniae thesaurus . . . Rome, p. 466).

C[anis] nudus (p. 230) = *Canis familiaris* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 38).—Name based on the "*xaloitzcuintli*" of Humboldt which is the Mexican hairless dog of Hernández (1651, Rerum medicarum Novae Hispaniae thesaurus . . . Rome, p. 479).

F[elis] nigra (p. 230) = *Felis onca* Linnaeus, 1758 (Syst. Nat., ed. 10, 1:42).—Name based on Azara's black variety of the *yaguareté*.

F[elis] Colorola (p. 231) = *Felis colocolo colocolo* Molina, 1782 (Sagg. Storia Nat. Chili, pp. 295, 341).

F[elis] mellivora (p. 231) = *Herpailurus yagouaroundi eyra* Fischer, 1814 (Zoognosia, 3: 228).—Both *mellivora* Olfers and *eyra* Fischer are based on Azara's *yagouaroundi*, or *eyra* cat, of Paraguay.

F[elis] rostrata (p. 231) = unidentifiable.—The name is attributed to Illiger (1815, pp. 109, 122) and the following source references are cited:

"*Viv*[*erra*] *r*[*ostrata*?] Erxl[eben] S. M. 499.

"*Eira* Az[ara] 1. 177?

"*V*[*orkommen*] *Sudamerica*"

Viverra rostrata does not appear in Erxleben's "Systema Regni Animali . . ." the work for which Olfers presumably uses the initials "S. M." [= Systema Mammalium?]. Illiger's *rostrata* is based on a young carnivore, possibly a procyonid, from Mexico, described and figured by Seba, 1734 (Locupl. rer. nat. thesauri, p. 76, pl. 48, fig. 1).

F[elis] Pampa (p. 231) = *Felis colocolo pajeros* Desmarest, 1816 (Nouv. Dict. Hist. Nat., 6: 114).—The names proposed by Olfers and Desmarest are based solely on the *Chat pampa* or *pajero* of Azara (1801, 1: 177).

F[elis] Nova Hispanica (p. 232) = *Felis pardalis pardalis* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 42).

M[ephitis] foeda (p. 232) = *Mephitis mephitis mephitis* Schreber, 1776 (Die Säugthiere, 3, [17]: pl. 121).—The name *Viverra foeda* was first used by Boddaert, 1784 (Elen. Anim., p. 84). It is based on references to Erxleben (1777, Regn. Anim., p. 491), *le chinche*

Buffon (1765, Hist. Nat., 13: pl. 39), the *skunk weesel* of Pennant (1793, Hist. Quadr., 2: 65) and Schreber (supra cit.). If Olfers' skunk is indeed from South America, as stated, it would be a species of *Conepatus* rather than of *Mephitis*.

M[ephitis] chilensis (p. 232) = *Conepatus chinga chinga* Molina, 1782 (Sagg. Stor. Nat. Chili, pp. 288, 342).

M[ustela] lanata (p. 232) = *Nasua nasua nasua* Linnaeus, 1766 [see page 000 below].—The name is based on the "*petite fouine de la Guyane* Buff." (1776, Nat. Hist., Suppl. 3: 162, pl. 24).

M[ustela] Guiqui [sic] (p. 232) = *Galictis cuja* Molina, 1782 (Sagg. Storia Nat. Chili, pp. 291, 342).—Olfers' *guiqui* is a misspelling of *Mustela quiqui* Mclina.

L[utra] gracilis Shaw (p. 233) = *Enhydra lutris* Linnaeus, 1758 (Syst. Nat., ed. 12, 1: 45).—The type locality of *Lutra gracilis* Shaw, 1800 (Gen. Zool., 1, (2): 447), is "Staatenland," or Kunachiri, one of the Kurile Islands, and not Isla de los Estados, Tierra del Fuego, Argentina. The otter of the South American "Staatenland" is *Lutra felina* Molina. Possibly Olfers meant to record the latter rather than the otter described by Shaw.

L[utra] longicaudis (p. 233) = *Lutra longicaudis* Olfers, 1818.—Antedates *Lutra platensis* Waterhouse, 1838 (Zool. Voy. "Beagle," no. 2, [2]: 21). The original diagnosis is "brunnea, gula et abdomine fulvis, cauda femoribus longiore." Long. corp. 2′ 5″, caudae 1′ 3½″.

L[utra] nitens (p. 233) = *Pteronura brasiliensis* Zimmermann, 1780 (Geogr. Geschichte, 2: 316).

? **M** [?] **lupina** (p. 233) = a *nomen nudum*.—It appears from the text that the initial "*M.*" stands for *Mustela* or should read "*L.*" for *Lutra*. Illiger's (1815: 110) *Lutra lupina* is also a *nomen nudum*.

M[?] **flavicans** (p. 233) = a *nomen nudum*.—As in the above, "*M.*" represents *Mustela* or is a lapus for "L." signifying *Lutra*. The [*Lutra*?] *flavicans* of Illiger (1815: 110) is also a *nomen nudum*.

M[anatus] fluviatilis (p. 235) = *Trichechus manatus manatus* Linnaeus, 1758 (Syst. Nat., ed. 10, 1: 34).—Olfers' primary basis for the name is the Guianan *manati* of Pennant (1793, Hist. Quadr. 2: 297). His other synonyms, *Tr*[*ichechus*] *Clusii* Shaw and *Tr*[*ichechus*] *Amazonius* Shaw (1800, Gen. Zool., 1, [1]: 246) are freshwater representatives of the common Antillean manatee.

SECTION II

Philander opossum frenata Olfers

D[*idelphys*] *frenata* Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 107—*nomen nudum*.

D[*idelphys*] *frenata* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 204—name in text with valid description.

D[*idelphys*] *superciliaris* Illiger, 1815, Abh. Akad. Wiss., Berlin, 1804–1811: 107—*nomen nudum*.

D[*idelphys*] *superciliaris* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 204—name in text with valid description.

Didelphis myosuros Temminck, 1825, Monogr. Mamm., 1: 38—type locality, Brazil.

D[*idelphys*] *myosuros* Wied-Neuwied, 1826, Beitr. Naturg. Brasil., 2: 400—type locality, "Comechatibá," [= Comoxatibá], on coast about 17°10′ S, southern Bahia, Brazil; name attributed to Temminck and cited from "Monogr. pag. 38" [a work which bears the publication date 1827 but the part in question was issued in 1825].

D[*idelphys*] *myosurus* [sic], Wagner, 1843, Schreber's Säugth., Suppl., 3: 43, footnote 25 page 44—Brazil: Bahia; type of *D. frenata* "Lichtenstein."

Didelphis quica Temminck, 1825, Monogr. Mamm., 1:36—type locality, Brazil; cotype collected 3 March, 1818, in Sapitibi, Rio de Janeiro, Brazil, by Johann Natterer [now designated lectotype].

Metachirus quica, Burmeister, 1856, Erlaut., Fauna Brasil., p. 70, pl. 7 (♂), pl. 8 (♀), pl. 9, fig. 2 (skull)—*Didelphys frenata* Illiger in synonymy. J. A. Allen, 1900, Bull. Amer. Mus. Nat. Hist., 13: 195—type locality, coast region of Brazil just south of Rio de Janeiro.

Didelphis larvata Jentink, 1888, Cat. Syst. Mamm. Mus. Pays-Bas, 12: 220—Natterer manuscript name on label of one of types of *quica* Temminck.

Type.—Presumably in the Berlin Museum; collected by Herr Kaehne.

Type locality.—Originally given as Brazil; according to Wagner (Schreber's Säugthiere, Suppl. 3: footnote 25 page 44) the specimen labeled *D. frenata* in the Berlin Museum was collected by Herr Kaehne in Bahía; this then may be taken as the restricted type locality.

Remarks.—Olfers treats *frenata* and *superciliaris* as varieties of "*D*[*idelphys*] *Opossum* L[innaeus]." However, the true Linnaean *opossum* is based on Seba's *carigueia* with type locality restricted to Surinam (cf. Thomas, 1911, Proc. Zool. Soc. London, 1911: 143) while Olfers' *opossum* is the eastern Brazilian *carigueia* of Marcgrave and Piso. No precise locality was given for the type of either *frenata* or *superciliaris*, but Olfers remarked that neither differed from specimens from the vicinity of Rio de Janeiro. As shown above, the Bahía specimen from the Berlin Museum recorded by Wagner is almost certainly the type.

In the original description of *Didelphis myosuros*, Temminck (1825, Monogr. Mamm., p. 38) states that "les femelles ont une poche complete." In this connection he also notes that *Didelphis* [i.e. *Metachirus*]*nudicaudata* E. Geoffroy differs from his *myosuros* precisely by the absence of a marsupium in the female. In spite of this unequivocal differentiation, *myosuros* is unaccountably treated in current treatises as conspecific with *Metachirus nudicaudatus*.

The name *myosuros* is based on Brazilian four-eyed opossums in the Leiden, Vienna, Frankfort and Prince Maximilian von Wied-Neuwied museums. The specimen in the latter collection, with type locality Comoxatibá, Bahía, is selected as lectotype.

Marmosa pusilla Desmarest

Micouré quatrième, ou micouré à queue longue Azara, 1801, Essais Hist. Nat. Paraguay, Paris, 1: 290.

Micouré sixième, ou micouré nain Azara, 1801, Essais Hist. Nat. Paraguay, Paris, 1: 304.

Colilargo Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 1: 251.

Enano Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 1: 262.

Didelphis pusilla Desmarest, 1804, Dict. Hist. Nat., Paris, 24: 19—name based solely on the *micouré nain*.

Marmosa pusilla, Tate, 1933, Bull. Amer. Mus. Nat. Hist., 66: 221, pl. 12, fig. 114 (skull), pl. 25, fig. 236 (skull)—synonyms: *micouré nain* Azara, *enano* Azara, *nana* Illiger (*nomen nudum*), "*nana Oken*," *marmota* Thomas, *citella* Thomas; ARGENTINA: Goya, Corrientes; Estancia Coropa, Corrientes; La Paz, Entre Rios.

D[*idelphys*] *macrura* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 205—name based solely on the *micouré à queue longue* and believed to be synonymous with *D. murina* L. "[=*Marmosa murina* Linnaeus]; type locality, Tapoua, northeast of Asunción, Paraguay.

D[*idelphys*] *nana* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 206—new name for *pusilla* Desmarest.

Didelphis grisea Desmarest, 1827, Dict. Sci. Nat., 47: 393—name based solely on the *micouré à queue longue*.

Micoureus griseus Thomas, 1894, Ann. Mag. Nat. Hist., (6), 14: 184—ARGENTINA: Goya, Corrientes.

Marmosa marmota Thomas, 1896, Ann. Mag. Nat. Hist., (6), 18: footnote pp. 313–314—name based on the *micouré à queue longue* and attributed to Oken, 1816 (Lehrb. Naturg., 3, Zool. 2: 1140); *Didelphis grisea* Desmarest, a synonym. Thomas, 1902, *op. cit.*, (7), 10: 158—comparisons with *M. elegans*. Thomas, 1912, *op. cit.*, (8), 9: 409 (in text)—

PARAGUAY: Sapucay; Asunción; comparisons; measurements. Thomas, 1921, *op. cit.*, (9), 7: 521—type locality, Tapoua, Paraguay.

Marmosa marmota marmota, Tate, 1933, Bull. Amer. Mus. Nat. Hist., 66: 218—synonyms: *micouré à queue longue* Azara, *colilargo* Azara, *grisea* Desmarest; PARAGUAY: "Paraguay"; Sapucay; Asunción.

Marmosa citella Thomas, 1912, Ann. Mag. Nat. Hist., (8), 9: 409—type locality, Goya, Corrientes, Argentina; type, the specimen identified as *Micoureus griseus* Desmarest, by Thomas in 1894 [supra cit.].

Marmosa verax Thomas, 1921, Ann. Mag. Nat. Hist., (9), 7: 520—type locality, Misión, west of Concepción, Chaco, Paraguay.

Marmosa marmota verax Tate, 1933, Bull. Amer. Mus. Nat. Hist., 66: 220—PARAGUAY: Misión, Chaco, 100 meters altitude; Bermalcué, Chaco.

Type.—Not known to be in existence; name based solely on a bibliographic reference to Azara's *micouré à queue longue*.

Type locality.—"Saint-Ignace-Gouazou" = San Ignacio, (approximately 27° S, 57° W) Misiones, northern Argentina.

Remarks.—It appears that all named forms of fat-tail marmosas comprising the "*elegans* group" of Tate (1933, Bull. Amer. Mus. Nat. Hist., 66: 209) are conspecific and referable to *Marmosa pusilla*. Tate divided the "group" into an "*elegans* section" with 4 species (including *pusilla* and *marmota*) and a "*pallidior-venusta* section," with 5 species. Osgood (1943, Field Mus. Nat. Hist. Zool. Ser., 30: 46) critically examined this classification and demonstrated that *pallidior* and *venusta* are no more than subspecies of *Marmosa elegans* "with the reservation that future collections may easily show that all are connected with *pusilla*, which was the first of the [*elegans*] group to receive a name."

Many authors, including Tate, failed to appreciate the fact that mouse opossums, or marmosas, as I prefer to call the American forms, become sexually mature before they are half grown. Such young animals of one species have often been classified as specifically distinct from fully developed individuals of the same species. There are striking differences between the age groups in the shape of the skull and degree of development of the supraorbital and temporal ridges. Local and individual variation in color, particularly of the underparts, has also influenced some authors into miscalculating the true relationships within the genus.

Azara's *micouré nain* and his *micouré á queue longue* are the basis for the names *pusilla* Desmarest and *macrura* Olfers (=*marmota* of authors), respectively. The measurements of the two marmosas, according to Azara, are, respectively, head and body, 89, 100; tail, 98, 135. These measurements are of a juvenile, no doubt sexually immature, and of a half-grown but mature individual. They are not measurements that necessarily belong to two different species. In comparing the *micouré nain*, or *Marmosa pusilla*, with the *micouré à queue longue*, or "*Marmosa marmota marmota*," Tate (*op. cit.*, p. 222) diagnosed the first as "much smaller . . . with perfectly white instead of creamy underparts." These differences are hardly trenchant and are completely canceled out, if not contradicted, by Tate's characterization of *Marmosa marmota verax* as being of the same "size as in *pusilla*; much smaller than *marmota*" and with underparts "buff-white."

The above synonymy includes only the names of forms here regarded as absolutely identical with typical *M. pusilla*. A revision of the intraspecific status of each of the other named forms of Tate's "*elegans* group" is not relevant to the present study. It is suggested, nevertheless, that for the present the forms recognized by Osgood (supra cit.) as subspecies of *Marmosa elegans*, be treated, instead, as subspecies of *Marmosa pusilla*.

Monodelphis brevicaudis Olfers

Micouré cinquième, ou micouré à queue courte Azara, 1801, Essais Hist. Nat. Quadr. Paraguay, Paris, 1: 295.

Colicorto Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 1: 258.

D[idelphys] brevicaudis Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 205.
[Monodelphis] wagneri Matschie, 1916, Sitzungsb. Gesellsch. naturf. Fr. Berlin, 1916: 272—"nov. nom. für *D. brachyura* Wagn. (Azara's *micouré à queue courte*). Die Säugthiere, Leipzig, 1855, 252—Paraguay."

Type.—Not known to be in existence; name based on a bibliographic reference to the *micouré à queue courte.*

Type locality.—Paraguay.

Remarks.—The practical identity of the names *brevicaudata* Erxleben (1777) and *brevicaudis* Olfers are confusing. Unfortunately, the latter cannot be treated as a homonym, an emendation or a *lapsus calami* of the former. In the first place, Olfers attributed the name *brevicaudis* to Illiger, not to Erxleben. Secondly, *brevicaudis* is based solely on Azara's *micouré à queue courte* with type locality stated to be Paraguay. Erxleben's *brevicaudatus,* on the other hand, was proposed long before Azara's work was published and is based primarily on Seba's *muris silvestris americani femina,* from Surinam. Finally, Olfers used the name *brachyura* Gmelin, a synonym of *brevicaudata* Erxleben, for the Guianan *tuan.* It is evident, therefore, that Olfers regarded the Paraguayan *micouré à queue courte* as a distinct species and used *brevicaudis,* Illiger's erstwhile *nomen nudum,* as the first valid name for it.

Caluromys lanatus lanatus Olfers

Micouré second ou micouré laineux Azara, 1801, Essais Hist. Nat. Quadr. Paraguay, Paris, 1: 275.
Lanoso Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 1: 221.
[Didelphys] lanata Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 107—*nomen nudum.*
D[idelphys] lanata Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 206—name based solely on Azara's *micouré laineux.*
Didelphis lanigera Desmarest, 1820, Mammalogie, p. 258—name based on Azara's *micouré second ou micouré laineux.*

Type.—In alcohol, no. 528, Museo de Ciencias Naturales, Madrid, collected 22 July 1789, by Felix Azara (Cabrera, 1916, Bol. Real Soc. española Hist. Nat., 16: 1).

Sciurillus guajanensis Kerr

Petit guerlinguet Buffon, 1789, Hist. Nat., Suppl., 7: 261, pl. 46—Cayenne; collected by M. de la Borde.
Sciurus guajanensis Kerr, 1792, Animal Kingdom, p. 265.
[Sciurus] Guajanensis Turton, 1802, Linnaeus Syst. Nat., p. 94—name based on the *petit guerlinguet* of Buffon; type locality, Cayenne.
Sciurus pusillus E. Geoffroy, 1803, Cat. Mamm. Mus. Hist. Nat., Paris, p. 177—based on the original *petit guerlinguet* of Buffon; type in Paris Museum; type locality, Cayenne. Anthony and Tate, 1935, Novit. Amer. Mus. Nat. Hist., no. 780: 1—taxonomic history; characters.
Sc[iurus] pusillus Desmarest, 1817, Nouv. Dict. Hist. Nat., 10: 109—specimen sent by Sonnini de Manoncour from French Guiana.
Sciurus guianensis Goldfuss, 1809, Vergl. Naturb. Säugth., p. 122—based solely on the *petit guerlinguet* of Buffon.
[?] *Sc[iurus] olivascens* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 208—name from Illiger manuscript based solely on the "Petit Guerlinguet Buff.?"
Macroxus Kuhlii Gray, 1867, Ann. Mag. Nat. Hist., (3), 20:433—type from Brazil, in British Museum; collected by Castelnau.
Sciurus leucotis, Gray (not Gapper, 1830), 1867, Ann. Mag. Nat. Hist., (3), 20: 433—Castelnau manuscript name for type of *Macroxus Kuhlii.*
Sciurillus pusillus glaucinus Thomas, 1914, Ann. Mag. Nat. Hist., (8), 13: 575—type

locality, Great Falls of Demerara River, British Guiana; type collected by Cozier, in British Museum.

Sciurillus pusillus hoehnei Miranda Ribeiro, 1941, O Campo, Rio de Janeiro, 12: 139—type locality, Rio Telles Pires (São Manoel), northern Mato Grosso.

Type.—No. CCCXLV of the original catalogue of the Museum National d'Histoire Naturelle, Paris; collected by M. de la Borde (cf. E. Geoffroy, 1803, Cat. Mus. Hist. Nat., Paris, p. 177).

Type locality.—Cayenne, French Guiana.

Sciurus spadiceus Olfers

Sc[iurus] spadiceus Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 208.

Sciurus Langsdorfii Brandt, 1835, Mem. Acad. Imp. Sci., St. Petersburgh, (6), 3, (2): 89, pl. 11, fig. 1 (animal and skull)—type locality, Brazil, restricted to Cuyabá, Mato Grosso, by J. A. Allen (1915, Bull. Amer. Mus. Nat. Hist., 34: 277).

Sciurus pyrrhonotus Wagner, 1842, Arch. Zool., (8), 1: 360—type locality, Borba, Rio Madeira, Amazonas, Brazil.

Sciurus tricolor Tschudi, 1844, Fauna Peruana, 14: 156, 160, pl. 11 (animal)—type locality, Maynas, lower Río Huallaga, Peru.

[?] *Sciurus Morio* Wagner, 1848, Abh. Akad. Wiss. Munich, 5: 275—type locality, Marabitanas, Rio Negro, Amazonas, Brazil.

[?] *Macroxus fumigatus* Gray, 1867, Ann. Mag. Nat. Hist., (3), 20: 428—type locality, upper Amazonas, Brazil.

[?] *Macroxus bruneo-niger* Gray, 1867, Ann. Mag. Nat. Hist., (3), 20: 429—type locality, Brazil.

Sciurus castus Thomas, 1903, Ann. Mag. Nat. Hist., (7) 11: 488—type locality, Chimate, upper Río Beni, Beni, Bolivia.

Urosciurus nigratus Oliviera Pinto, 1931, Rev. Mus. Paulista, São Paulo, 17: 309—type locality, Rio Juruá, Amazonas, Brazil.

Type.—Originally in the Berlin Zoological Museum.

Type locality.—Brazil; here restricted to Cuyabá, Mato Grosso, the type locality of *Sciurus langsdorfii* Brandt (cf. Wagner, 1848, Abh. Akad. Wiss., München, 5: 273–275).

Remarks.—Giant squirrels of tropical South America east of the Andes appear to be separable into two species. One is the extremely large, long-muzzled, usually dark, often melanistic form, *Sciurus spadiceus* Olfers. The other is smaller, more brightly colored with normal muzzle, for which the name *Sciurus igniventris* Wagner is the oldest. The characters of each species are summarized as follows:

Sciurus spadiceus Olfers.—Largest of tropical American squirrels, skull long, relatively narrow and flattened in dorsal contour, condylobasal length in fully developed adults normally more than 59 mm.; muzzle elongate; braincase, measured across parietals, approximately 30 to 43 per cent of condylobasal length; temporal ridges well developed, distance between them at plane of fronto-parietal suture from 15 to 26 per cent of condylobasal length, strongly convergent posteriorly and nearly always uniting to form a single crest on well-defined interparietal bone; sphenopalatine fissure enlarged, its long axis about one and one-half times or more diameter of optic foramen; lower incisor elongate, chord of exposed portion longer, infrequently slightly shorter, than height of condylar process measured vertically from mandibular base. Upper surface of fore and hind feet always as dark or darker than shoulders and thighs, respectively, the hair entirely black or mixed reddish and black, the digital bristles usually dark reddish or black; crown black or with a more or less well-defined dark cap; postauricular tufts, if present, not well defined; distinct black lateral line defining sides from ventrum never present.

Olfers' description of *spadiceus* is as follows: "*Dorso et lateribus spadiceo nigroq. variis, capite superne obscuriore, abdomine albido, cauda nigro ferruginea, pilis nigris, apice*

ferrugineis. Long. corp. 10¼″ [= 267.5 millimeters], *caudae* 9½″ [= 248 mm.]. V[orkommen] Brasilien."

The date of discovery, the locality and the characters of *Sciurus spadiceus* point only to a Brazilian giant squirrel with a slightly bobbed tail. It may be identical with *S. langsdorffi* and the type locality has been restricted accordingly.

Sciurus igniventris Wagner (1842, Arch. Naturg., [8], 1: 360).—Slightly smaller than *S. spadiceus*, skull relatively broader, more rounded in dorsal contour, condylobasal length normally less than 63 mm.; muzzle moderately long; braincase, measured across parietals, approximately 43 to 48 per cent of condylobasal length; temporal ridges moderately well developed, distance between them at plane of fronto-parietal sutures approximately 24 to 34 per cent, convergent posteriorly but usually separated on interparietal; sphenopalatine fissure small or obsolete, its long axis never more than approximately subequal to diameter of optic foramen; lower incisor normal, chord of exposed portion always shorter than height of condylar process measured vertically from mandibular base. Upper surface of fore feet and forearms ochraceous to reddish-orange in marked contrast with darker color of shoulders; upper surface of hind feet like forefeet, markedly paler (or lighter) than thighs; crown usually ochraceous or orange, without well-defined dark cap; contrastingly bright postauricular tufts always present; black lateral band defining ventrum from sides often present.

The type locality of *Sciurus igniventris* Wagner is Marabitanas, upper Rio Negro, Brazil.

The above characterizations are based on 83 specimens of *spadiceus* and 29 of *igniventris*, the two lots representing most of the named forms of giant squirrels. In computing differences between the species, no distinction was made between sexes and age classes except for the obviously immature, which were discounted. This lack of fine discrimination may account for a fraction of the overlap in measurements between the two species.

In present material wholly or dominantly melanistic individuals are common in populations of *Sciurus spadiceus* while melanism is usually confined to the dorsum in some individuals of *S. igniventris*. White on the underparts is also more prominent and more widespread in *spadiceus* than in *igniventris*.

The two species occur together in many localities, and the larger *S. spadiceus* appears to be nothing more than a mutant of the smaller *igniventris*. It is possible that in other localities the characters attributed to each species defined here may be fully intergrading. This possibility was adopted by Thomas (1928, Ann. Mag. Nat. Hist., [10], 2: 289) as fact. He did not show, however, wherein the combination of external and cranial characters of each specimen is not in harmony with the present definition of each of the two species.

A complete synonymy of the giant squirrels will be given elsewhere.

Oryzomys buccinatus Olfers

Rat troisième ou rat angouya Azara, 1801, Essais Hist. Nat. Quadr. Paraguay, Paris, 2: 86.

Anguya Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 2: 89.

M[us] buccinatus Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 209.

Mus angouya Desmarest, 1819, Nouv. Dict. Hist. Nat., 29: 62—name based solely on Azara's *rat angouya*.

Mus Anguya [sic], Rennger, 1830, Naturg. Saeugeth. Paraguay, 1830: 229.

Hesperomys leucogaster Wagner, 1845, Arch. Naturg., (10) 1:147—type locality, Ypanema, São Paulo, Brazil.

Hesperomys ratticeps Hensel, 1873, Abh. Akad. Wiss. Berlin, 1872: 36, figs. 15, 25 (dentition)—type locality, Rio Grande do Sul, southeastern Brazil.

Calomys rex Winge, 1888, E Mus. Lundii, 3: 50, pl. 3, fig. 8 (skull)—type locality, Rio das Velhas, Lagôa Santa, Minas Geraes, Brazil.

Oryzomys ratticeps tropicius Thomas, 1924, Ann. Mag. Nat. Hist., (9), 14: 143—type locality, Piquete, São Paulo, Brazil.

Oryzomys ratticeps paraganus Thomas, 1924, Ann. Mag. Nat. Hist., (9), 14: 143—type locality, Sapucay, Paraguay.

Type.—None in existence, name based on a bibliographic reference to the *rat troisième ou rat angouya* of Azara.

Type locality.—Atyra (= Atira), Caraguatay, about 45 km. east of Asunción, Paraguay.

Remarks.—Azara's description of the *angouya* leaves no doubt of its identity with the species of *Oryzomys* subsequently described under the several names listed in the above synonymy. Brants (1827, Het Geslacht Muizen, p. 141) had already determined as an *angouya* the specimen in the Vienna Museum later described by Wagner as *leucogaster*. Characters detailed by Thomas (1924, *supra cit.*) for distinguishing *tropicius* Thomas and *paraganus* Thomas from each other and from *ratticeps* Hensel are of no systematic value. In addition, the type of *tropicius* is practically a topotype of *leucogaster* Wagner, *paraganus* bears the same relationship to *buccinatus*, and *ratticeps* is geographically intermediate.

Winge's *Calomys rex* is based on the anterior two-thirds of a skull and a mandible from the Pleistocene of Minas Gerais, Brazil. The original description, figures and measurements of the type agree in every detail with old adults of modern Paraguayan *buccinatus* in the collection of the Chicago Natural History Museum.

Reithrodon physodes Olfers

Rat quatrième, ou rat oreillard Azara, 1801, Essais Hist. Nat. Quadr. Paraguay, Paris, 2: 91.

Orejón Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 2: 82.

M[us] physodes Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 108—*nomen nudum.*

M[us] physodes Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 209—valid description.

Mus auritus Desmarest, 1819, Nouv. Dict. Hist. Nat., 29: 64—name based solely on a bibliographic reference to Azara's *rat quatrième ou rat oreillard.*

M[us] pyrrhogaster Brants, 1827, Het geslacht Muizen, p. 145—in synonymy of *M. auritus*; said to be a Natterer manuscript name for a specimen in the Vienna Museum.

Reithrodon typicus Waterhouse, 1837, Proc. Zool. Soc. London, 1837: 30—type locality, Maldonado, Uruguay.

Reithrodon cuniculoides Waterhouse, 1837, Proc. Zool. Soc. London, 1837: 30—type locality, Port Desire, Santa Cruz, Argentina.

Mus pachycephalus Philippi, 1900, Anal. Mus. Nac. Chile Entr. 14a, p. 42, pl. 17, figs. 6–6b (animal; skull)—type locality, Straits of Magellan, Chile, restricted to Punta Arenas, by Osgood (1943, Field Mus. Nat. Hist., Zool. Ser., 30: 221).

Reithrodon cuniculoides obscurus J. A. Allen, 1903, Bull. Amer. Mus. Nat. Hist., 19: 190—type locality, Punta Arenas, Straits of Magellan, Chile.

Reithrodon hatcheri J. A. Allen, 1903, Bull. Amer. Mus. Nat. Hist., 19: 191—type locality, head of Río Chico, Santa Cruz, Argentina.

Reithrodon cuniculoides flammarum Thomas, 1912, Ann. Mag. Nat. Hist., (8), 10: 411—type locality, Spring Hill, Tierra del Fuego, Chile.

Reithrodon cuniculoides pampanus Thomas, 1916, Ann. Mag. Nat. Hist., (8), 18: 304—type locality, Peru, a railway station, about 200 km. northwest of Bahia Blanca, Argentina.

Reithrodon caurinus Thomas, 1920, Ann. Mag. Nat. Hist., (9), 5: 473—type locality, Otro Cerro, Catamarca, Argentina, 3000 m. above sea level.

Reithrodon auritus marinus Thomas, 1920, Ann. Mag. Nat. Hist., (9), 5: 474—type locality, Mar del Plata, Argentina.

Reithrodon typicus currentium Thomas, 1920, Ann. Mag. Nat. Hist., (9), 5: 475—type locality, Goya, Corrientes, Argentina, 600 feet above sea level.

Reithrodon cuniculoides evae Thomas, 1927, Ann. Mag. Nat. Hist., (9), 19: 652—type locality, Zapala, Neuquén, Argentina, 1062 m. above sea level.

Type.—Not known to be in existence, name based solely on a bibliographic reference to Azara's *rat quatrième ou rat oreillard.*

Type locality.—"Les Pampas, au Sud de Buenos-Ayres"; i.e., south bank of the Río de la Plata.

Remarks.—The genus *Reithrodon* is monotypic. It is possible, however, that one or more of the synonyms of *R. physodes* are valid as subspecific names.

Chaetomys subspinosus Olfers

[*Hystrix*] *tortilis* Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 108—*nomen nudum.*

H[*ystrix*] *subspinosa* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 211—valid description and renaming of *tortilis* Illiger. Kuhl, 1820, Beitr. Zool., p. 71. Wied-Neuwied, 1826, Beitr. Naturg., 2: 440—type from Cametá, collected by Sieber.

P[*lectrochoerus*] *moricandi* Pictet, 1843, Rev. Zool., Paris, pp. 225 (description), 227 (name)—type locality, Pará, Brazil; type presented to the Geneva Museum by M. Moricand.

H[*ystrix*] *rutila* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 211—type locality, Pará, Brazil; "wahrscheinlich ein Junges irgend einer noch unbekannten Art."

H[*ystrix*] *volubilis* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 212—Illiger maunscript name for an anomalous specimen of *H. tortilis* Illiger.

Type.—In Berlin Museum; collected by von Sieber.

Type locality.—Cametá, Rio Tocantins, Pará, Brazil (Wied-Neuwied, 1826, Beitr. Naturg. Brasil., 2: 440).

Remarks.—Olfers introduces the diagnosis of the porcupine with Illiger's *nomen nudum* as follows: *"H. tortilis* Ill. *lucide brunnea, spinis brevioribus tortilibus, pone medium corpus abientibus in setas duriusculas, ad basim caudae subnudae longissimas.* Long. 14½" caudae 9". *H. subspinosa* M B [= Museum Berolinense]. V[orkommen] Brasilien.

It is evident that Olfers used Illiger's *nomen nudum* for the sole purpose of identifying it with the description of the specimen for which the new name *H. subspinosus* is proposed. There is no question of priority here. Kuhl (1820, *supra cit.*) found the name *H. subspinosus* on the label of the type but thought it had been written by Lichtenstein.

The description of *H. rutila* is that of a juvenile less then one-half the size of the type of *subspinosa.*

Dasyprocta aguti fulvus Kerr

Rats musqués or *piloris* de Rochefort, 1658, Histoire Naturelle et Morale des Iles Antilles de l'Amérique, p. 124, fig. (of an aguti ex Marcgrave, 1648, Hist. Nat. Brasil., p. 224).

Musk cavy Pennant, 1771, Syn. Quadr., p. 247—description ex de Rochefort; animal said to be from Martinique. Pennant, 1781, Hist. Quadr., ed. 1, species no. 240. Pennant, 1793, Hist. Quadr., ed. 3, 2: 97.

M[*us*] *Pilorides fulvus* Kerr, 1792, Animal Kingdom, p. 227—description a composite but based primarily on the *musk cavy* of Pennant.

[*Dasyprocta*] *moschata* Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 108, 114—name based by implication on Pennant's *musk cavy.*

D[*asyprocta*] *moschata,* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 214—sole reference, *"musk cavy* Penn."

Dasyprocta antillensis Sclater, 1875, Proc. Zool. Soc. London, 1874: 666—type locality, Santa Lucia, Lesser Antilles.

Type.—None in existence; name based primarily on the *musk cavy* of Pennant which, in turn, is identical with the *rat musqué* or *piloris* of de Rochefort.

Type locality.—"The West India islands," i.e., "Les Iles Antilles" of de Rochefort. Pennant, however, specifies the island of Martinique.

Remarks.—The *rat musqué* described and figured by de Rochefort is undoubtedly an aguti. Pennant's account of the *musk cavy* is merely a translation of de Rochefort's.

The *rat musqué* or *musk cavy* has been confused with the *Mus pilorides* of Pallas and authors. The name proposed by Pallas (1778, Nov. Spec. Quadr. Glir., p. 91) is a composite of an unidentified East Indian rat and de Rochefort's West Indian rodent. The name *pilorides* has been restricted to the former. The Antillean vernacular name *pilori* and the technical name *Mus pilorides* have also been misapplied by some early Linnaean authors to an extremely large cricetine from the Antilles. This has been renamed *Mus Desmarestii* by Fischer (1829, Syn. Mamm., p. 316) and is now type of the oryzomyine genus *Megalomys* Trouessart.

West Indian agutis, whatever their present technical names, are certainly imports from the mainland of Central and/or South America.

Priodontes maximus Kerr

[*Largest armadillo*] Smellie, 1780, Buffon Hist. Nat., 5: 377, pl. 154—[description in text under heading "The twelve-banded armadillo," (p. 375) which is a composite].

Kabassou Buffon, 1763, Hist. Nat., 10: 218, 253, pl. 40, 41 (animal).

Tatou premier, ou grand tatou Azara, 1801, Essais Hist. Nat. Quadr. Paraguay, Paris, 2: 132.

Maximo Azara, 1802, Apunt. Hist. Nat. Quadr. Paraguay, Madrid, 2: 110.

Dasypus maximus Kerr, 1792, Animal Kingdom, p. 112.

D[*asypus*] *maximus* Turton, 1802, Linnaeus Syst. Nat., p. 34—*largest armadillo.*

Dasypus giganteus E. Geoffroy, 1803, Cat. Mamm. Mus. Hist. Nat., Paris, p. 207—type locality, Paraguay; name based on specimen no. ccccxiv in Paris Museum, and a bibliographic reference to Azara's *grand tatou.*

Dasypus gigas Cuvier, 1817, Regn. Anim., 1: 221—new name for the *tatou géant* of Geoffroy [= *Dasypus giganteus* E. Geoffroy].

T[*atus*] *grandis* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 219—type locality, Paraguay; name based solely on Azara's *grand tatou.*

Type.—None in existence; name based on the *largest armadillo* in Smellie's translation of Buffon's "Natural History . . ."

Type locality.—Cayenne, French Guiana.

Potos flavus prehensilis Kerr

Kinkajou Buffon, 1776, Hist. Nat., Suppl., 3: 245, pl. 50 (animal)—México.

Kinkajou Smellie, 1780, Buffon Hist. Nat., 7: 289, 3rd pl. no. 240—(in text under description of "the glutton").

Mexican weesel Pennant, 1793, Hist. Quadr., ed. 3, 2: 60.

Viverra prehensilis Kerr, 1792, Anim. Kingd., 1: 169.

Var.? *kinkajou* Shaw, 1800, Gen. Zool., 1, (2): 404—*Mexican weesel* of Pennant and *kinkajou* of Buffon regarded as probably a variety of *Viverra caudivolvula* Gmelin [*Potos flavus Schreber*].

[*Viverra*] *prehensilis* Turton, 1802, Linnaeus Syst. Nat., p. 55—type locality, México.

Cercoleptes lepida Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 109—*nomen nudum.*

[*Cercoleptes*] *lepidus* Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 227—type locality, México.

Potos flavus aztecus Thomas, 1902, Ann. Mag. Nat. Hist., (7), 9: 268—type locality, Atoyac, Veracruz, México.

Type.—None in existence; name based primarily on the *kinkajou* of Smellie's translation of Buffon.

Type locality.—México, here restricted to Atoyac, Veracruz.

Nasua nasua nasua Linnaeus

[*Viverra*] *Memphitis* Linnaeus (part, not Linnaeus), 1758, Syst. Nat., ed. 10, 1: 44—the diagnosis and reference to "Seba Mus. 1, p. 68, t. 42, f. 1," which is the Surinam *coati* or *quasje*.

[*Viverra*] *Nasua* Linnaeus, 1766, Syst. Nat., ed. 12, 1: 64—type locality, America.

[*Myrmecophaga*] *Striata* Boddaert, 1784, Elenchus Anim. p. 75—name based on the *fourmilier strié* or *tamandua* of Buffon (1776, Hist. Nat., Suppl. 3: 281, pl. 56).

[*Viverra*] *nasica*, Linnaeus, 1768, Act. Holm., p. 152, fig.

[*Viverra*] *quasje* Gmelin, 1788, Linnaeus Syst. Nat., ed. 13, 1: 87—description based primarily on the *ichneumon de yzquiepatl* or *quasje* of Seba (1734, Locupletissimi rerum naturalium thesari . . ., 1: 68, pl. 42, fig. 1 [animal])—type locality, Surinam.

Myrmecophaga pentadactyla Kerr, 1792, Animal kingdom, p. 106—name based on the *tamandua* of Buffon (supra cit.).

Mustela laniger Kerr, 1792, Animal kingdom, p. 177—name based on the *small Guiana martin* of Smellie's English translation of Buffon (1780, 4: 244, pl. 72).

M[ustela] minor Link, 1795, Beitr. Naturg., pt. 2, p. 82—name based on the *"petite foine* [sic] *de Guiane* Buff[on] v. 6 T. 33."

Nasua rufa E. Geoffroy, 1803, Cat. Mamm. Mus. Hist. Nat., Paris, p. 85—type locality, America.

Nasua pusillus E. Geoffroy, 1803, Cat. Mamm. Mus. Hist. Nat., Paris, p. 87—type locality, South America, restricted to French Guiana by Desmarest, 1804 (Dict. Hist. Nat., 24: 15).

Mustela Guianensis Lacépède, 1803, Buffon Hist. Nat., Didot ed., (1799), 13: 162—name based on the *petite fouine de la Guiane* of Buffon (1764, Hist. Nat., 11: 14).

Nasua annulata Wiedemann, 1805, Arch. Zool. Zoot., 4, (4): 250—name based on the *tamandua* of Buffon (1776, Hist. Nat. Suppl. 3: 281, pl. 56).

Mustela lanata Goldfuss, 1809, Vergleich. Naturb. Säugeth., p. 247—name based on the *petite fouine de la Guiane* of Buffon 1776 (Hist. Nat., Suppl., 3: 162).

M[ustela] lanata Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 232.

Nasua fusca Fischer, 1814, Zoognosia, 3: 176—type locality, tropical America.

N[asua] Monde Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 227—type locality, Brazil; name cited in synonymy of *N. rufa*. Lichtenstein, 1818, Verzeich. Säugeth. Vogeln, Zool. Mus. Berlin, p. 3.

N[asua] obfuscata Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 227—type locality, Brazil; name based primarily on the *"Coati Monde* Marcgr. 228." Lichtenstein, 1818, Abh. Akad. Wiss. Berlin, 1814–1815: 218.

N[asua] minor Olfers, 1818, in Eschwege, Journal von Brasilien, (15), 2: 227—type locality, Brazil; name cited in synonymy of *N. obfuscata*.

N[asua] Squash? Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 228—*nomen nudum*.

Nasua fusca Desmarest, 1820, Mammalogie, p. 170, pl. 85, fig. 2 (animal mislabelled *suricate*), fig. 3 (*coati*)—[name here restricted to the Brazilian coati but preoccupied by *Nasua fusca* Fischer, 1814 = *N. narica* Linnaeus].

Nasua solitaris Schinz, 1821, Cuvier Das Thierreich, 1: 199—type locality, Brazil.

Nasua sociabilis Schinz, 1821, Cuvier Das Thierreich, 1: 199— type locality, Brazil.

Nasua socialis Wied-Neuwied, 1826, Beitr. Naturg. Brasil, 2: 283—type locality, eastern Brazil.

Nasua solitaria Wied-Neuwied, 1826, Beitr. Naturg. Brasil., 2: 292—type locality, eastern Brazil.

Nasua coati Blainville, 1841, Osteographie, 2, (1): 32, 37, pl. 8–10 (skeletal parts), pl. 11 (dentition; name)—type locality unknown but probably French Guiana.

Nasua monachus Hamilton Smith, 1842, Jardine's Nat. Libr., 13: 220, pl. 18—no locality.

Nasua vulgaris F. Cuvier fils in E. Geoffroy and Cuvier, 1842, Nat. Hist. Mamm., 7: Table p. 3—the *coati roux* of Cuvier (op. cit.).

[*Nasua socialis*] *Aurea* Lesson, 1842, Nouv. Tabl. Reg. Anim., p. 77—name based on the *coati brun* var. of F. Cuvier, (supra cit., pl. 1).

N[*asua*] *vittata* Tschudi, 1844, Fauna Peruana, pp. 11, 101—type locality, vicinity of Mt. Roraima, British Guiana.

Nasua phaeocephala J. A. Allen, 1904, Bull. Amer. Mus. Nat. Hist., 20: 334—type locality, Suapure, Río Caura, Venezuela.

Nasua henselii Lönnberg, 1921, Ark. Zool., Stockholm, 14, (4): 102—type locality, Santa Catarina, Brazil.

Nasua candace dichromatica Tate, 1939, Bull. Amer. Mus. Nat. Hist., 76: 200—VENEZUELA: type locality, Mt. Auyan-tepui, 6000 feet altitude.

Type.—None in existence; description based primarily on the *coati-mondi* of Brisson (1756, Reg. Anim. p. 263) which, in turn, is the animal of the same name discovered by Marcgrave (1648, Hist. rerum Nat. Brasil, p. 228).

Type locality.—"America," restricted to Pernambuco, Brazil, the locale of most of the animals described by Marcgrave.

Remarks.—*Viverra memphitis* Linnaeus was dismissed by Allen (1901, Bull. Amer. Mus. Nat. Hist., 14: 331; 1902, Proc. Biol. Soc. Washington, 15: 64) and by Thomas (1911, Proc. Zool. Soc. London, 1911, (2): 137) as an unrecognizable composite of coati and skunk. This conclusion must be accepted because it appears that Linnaeus himself had no clear notion of what he was describing under the name *memphitis*. His first reference is to the "*ysquiepatl*. Hern[andez] *Mex.* 332," a composite of Mexican skunk and coati. The second bibliographic reference in the description is to "*Seb*[*a*] *mus.* 1. p. 68, t. 42, f. 1.," which is the Surinam coati or *quasje*. The third and final reference is to "Raj. quadr. 181," where the Mexican *ysquiepatl* is redescribed and partly confused with the *quasje*. *Viverra quasje* Gmelin (1788, supra cit.) is the recognizable *quasje* of Surinam and not a renaming of the unidentifiable *Viverra memphitis* Linnaeus. My citation of *memphitis* in the synonymy of *Nasua nasua* is solely for the purpose of isolating that part of the Linnaean description which pertains to the coati. This action is not to be construed as a restriction of the definition, or selection of the type, of *Viverra memphitis* Linnaeus.

Nasua nasua spadicea Olfers

[*Nasua*] *spadicea* Illiger, 1815, Abh. Akad. Wiss. Berlin, 1804–1811: 109—*nomen nudum*.

N[*asua*] *spadicea* Olfers, 1818, Journal von Brasilien, 15, (2): 227.

Nasua henselii cinerascens Lönnberg, 1921, Ark. Zool., Stockholm, 14, (4): 103—type locality, Río Bermejo, Chaco Austral, Argentina.

Nasua nasua aricana Vieira, 1945, Arq. Zool., São Paulo, 4:404—type locality, Fazenda Aricá, Rio Aricá, Cuiabá, Mato Grosso, Brazil.

Type.—In Berlin Museum.

Type locality.—None given, here designated Paraguay on the basis of the *couati* of Azara (1801, Essais Hist. Nat. Quadr. Paraguay, 1: 334) included by Olfers in the synonymy of his *N. spadicea*.

Procyon cancrivorus cancrivorus Brongniart

Raton crabier Buffon, 1776, Hist. Nat., Suppl., 3: pl. 44; Suppl., 6: 236, pl. 32—vernacular name for the crab-eating raccoon of French Guiana.

Koupara Zimmermann, 1780, Geogr. Geschichte, 2: 254—vernacular name for the crab-eater of the Guianas.

V[*iverra*] *Cancrivora* Brongniart, 1792, Act. Soc. Hist. Nat., Paris, 1, (1): 115.

C[ampsiurus] cancrivorus Link, 1795, Beitr. Naturg., 2: 87—name based on the *raton crabier* of Buffon.

Canis koupara Wolf, 1796, Linnaeus Vollst. Natursyst., Nürnberg, 1: 199—name based on the koupara of Surinam; type locality given as Martinique derived from the extraneous *Canis americanus sylvestris* of Seba.

Ursus cancrivorus Cuvier, 1798, Tabl. Element., p. 113—name based on the *raton crabier* of Buffon; type locality, French Guiana.

[*Procyon*] *concolor* Fischer, 1814, Zoognosia, 3: 178—substitute name for *Ursus cancrivorus* Cuvier.

N[asua]? canina Olfers, 1818, in Eschwege, Journal von Brasilien, 15, (2): 228—name based solely on the *koupara* of Zimmermann; regarded as possibly a *Procyon*, if not a *Nasua*.

Type.—Possibly in the Museum National d'Histoire Naturelle, Paris.

Type locality.—Cayenne, French Guiana.

Remarks.—Inclusion of the vernacular name *chien crabier de Cayenne* by Brongniart in his description of *Viverra cancrivora* led some authors to associate the animal with the canid *Dusicyon thous* Linnaeus. However, the original diagnosis of *Viverra cancrivora*, "*supra fusca adspersa, infra flavofulva; capite cinereo, macula nigricante oculis circumacta,*" refers only to the South American raccoon. The true wild dog or zorro, *Dusicyon thous*, was classified by Brongniart (loc. cit.) as *Canis tetradactylus*, or the *chien sauvage de Cayenne*.

Zimmermann's description of the *koupara* is a composite of the French Guianan *koupara*, or crab-eater, of Barrere (1741, Essai Hist. Nat. France Equinox. p. 149), the *crabedago*, or crab-eating "dog" of Fermin (1769, Descr . . . Surinam, 2: 120–121), and the *Canis americanus sylvestris cauda longissima* of Seba (1734, Locup. rerum Nat. thesauri . . ., 1: 47, pl. 30, fig. 1). The description of the Guianan animals given by the first two authors, taken together with the vernacular names, point only to raccoons. Seba's carnivore, however, is said to be from Martinique. Its description and figure indicate a kinkajou. First reviser Illiger (1815, Abh. Akad. Wiss. Berlin, 1804–1811: 120) had already identified the *koupara* of Surinam with *Procyon cancrivorus*. This opinion appears to be correct and all names based by authors on the *koupara* are, therefore, automatically restricted to the raccoon.

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Chicago Natural History Museum. Received January 17, 1958.

EFFECTS OF SODIUM CHLORIDE ON WEIGHT AND DRINKING IN THE ANTELOPE GROUND SQUIRREL

By George A. Bartholomew and Jack W. Hudson

The fossorial and nocturnal habits of most desert rodents minimize water loss and contribute to their capacity to exist without drinking water. However, a few desert rodents are diurnal and therefore contend with high environmental temperatures and intense solar radiation which pose particularly acute problems of water conservation. Among these diurnal forms is the antelope ground squirrel, *Citellus leucurus*, which occurs widely in the desert and semidesert regions of western North America and often lives where there is no surface water whatsoever. It is of interest, therefore, to examine two aspects of the water economy of this animal: water consumption which offers an index to water needs, and ability to drink saline solutions which bears a relationship to kidney function.

MATERIALS AND METHODS

The ground squirrels were captured during the summer and fall of 1956 in the Antelope Valley of the Mohave Desert of California. They were housed in a windowless room on a 12-hour photoperiod. The ambient temperature varied between 19° and 25°C. during the months of the experiment and on any one day the range never exceeded 2°C. Relative humidity ranged between 50 and 80 per cent during the period of study.

Water consumption was measured with inverted graduated cylinders equipped with "L"-shaped drinking tubes (see Bartholomew and Dawson, 1954). One drinking device was used to correct for evaporation. Spillage was minimized by allowing the animals access only to the aperture of the "L"-shaped tube. In the summer experiments the animals were housed individually. In the fall and spring experiments they were housed in groups and each group drank from a single watering device. Unless otherwise stated, the food consisted of unshelled sunflower seeds and was present in excess at all times. Oven desiccation to a constant weight indicated that the moisture content of the food approximated 10 per cent. The animals were weighed to the nearest 0.1 gram, usually in the late afternoon, and at the same time the water consumption was noted.

The animals adapted readily to laboratory conditions. Except on the water deprivation experiments there was no mortality. When the animals were housed in groups, they lived amicably and often huddled together.

RESULTS

Water requirements.—The wild population from which our animals were taken probably never has access to water for drinking and must depend on succulent food and metabolic water. Under laboratory conditions, without heat stress and on a diet of sunflower seed, the ground squirrels could not survive without water. Eight animals captured at the end of September were kept in the

laboratory without water for nine days. One squirrel died on the sixth day and was eaten by the others. The weights of the surviving animals decreased by more than 20 per cent during water deprivation. At the end of the ninth day they were given distilled water and within 48 hours had regained their initial weights. During the following week they continued to gain slightly but insignificantly (Fig. 1).

During our studies consumption of distilled water was measured for 121 animal-days on 13 unstressed squirrels. The mean daily consumption was 0.12 cc./gm./day. Freshly captured animals averaged as much as 0.16 cc./gm./day while fat animals that had been long in captivity averaged as little as 0.07 cc./gm./day.

Effects of drinking solutions of NaCl.—An attempt to determine the highest molarity of NaCl on which the ground squirrels could maintain body weight was made by gradually increasing the salinity of their drinking water (Fig. 2). They gained weight on 0.25 molar; held almost constant on 0.5 and 0.6 molar; and lost weight on 1.0 molar. By the end of a month the animals had apparently become somewhat acclimated to a salt regimen. Previously they had failed to gain weight on 0.6 molar NaCl, but they now gained rapidly on 0.77 molar. They subsequently lost weight on 0.9 molar and then gained on 0.8 molar. When the animals were transferred from distilled water to 0.25 molar NaCl, their water consumption increased by 50 per cent. At all molarities above 0.25 the animals drank less. In a general way drinking decreased as molarity increased. Although

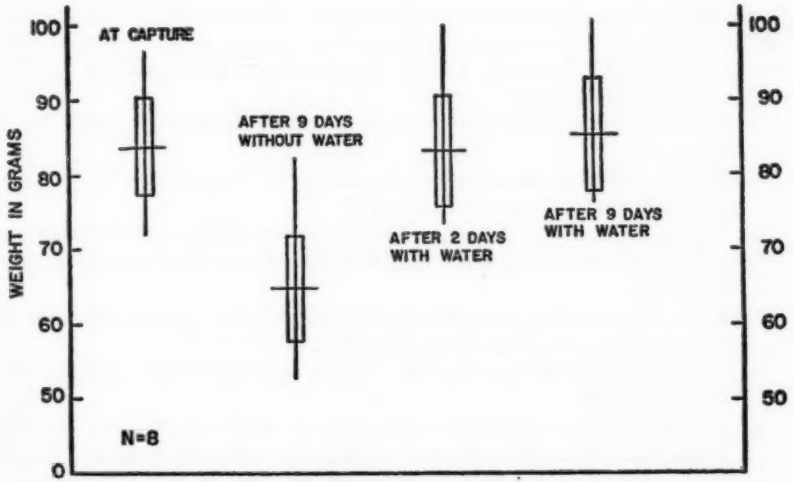

FIG. 1.—Weight changes during dehydration and rehydration in adult antelope ground squirrels. The vertical lines indicate the range; the horizontal lines indicate the mean (M); the rectangles indicate the interval $M + 2\sigma_M$ to $M - 2\sigma_M$; N indicates the number of animals used.

TABLE 1.—*Relation of salt acclimation, state of hydration, and ingestion of NaCl solutions*

EXPERIMENT	MOLARITY, NACL	NUMBER OF ANIMALS	DURATION OF EXPERIMENT, DAYS	MEAN INITIAL WEIGHT, GM.	σ_M	MEAN FINAL WEIGHT, GM.	σ_M	MEAN WATER DRUNK CC./GM./DAY	MG. NACL/GM./DAY	REMARKS
I	0.4	8	18	81.2	1.3	89.6	2.5	.129	3.02	Freshly captured.
	0.8	8	18	84.7	1.8	81.4	5.3	.067	3.14	Freshly captured.
II	0	14	135	85.9	3.6	104.5	3.6	—	—	Distilled water and food *ad libitum*.
III	0.4	7	5	105.8	3.6	104.2	3.6	.089	2.08	Animals from Exp. II divided
	0.8	7	5	103.1	3.7	90.3	3.6	.061	2.85	into two groups.
IV	0.4*	7	37	104.2	3.6	110.2	3.8	—	—	Acclimation period, drinking
	0.4†	7	37	90.3	3.6	105.8	4.5	—	—	not measured.
V	0.4	7	14	105.8	4.5	107.5	5.1	.066	1.54	Experiment follows 37-day
	0.8	7	14	110.2	3.8	104.6	3.8	.052	2.40	acclimation to 0.4 molar NaCl.

* Animals which had been on 0.4 molar NaCl in experiment III.
† Animals which had been on 0.8 molar NaCl in experiment III.

water consumption apparently depended on salinity, the utilization of the salt solutions changed as the animals adjusted to the salt regimen over the many weeks that measurements were made.

We therefore undertook to study the effects of salt acclimation and state of hydration by measuring ability to utilize 0.4 and 0.8 molar NaCl solutions (1) after field capture, (2) after 4½ months on distilled water and (3) after 37 days on 0.4 molar NaCl. The results of these experiments are summarized in Table 1 which shows the following:

1. Freshly captured animals gained weight while drinking 0.4 molar NaCl (Exp. I).
2. Freshly captured animals showed a slight but insignificant weight loss while drinking 0.8 molar NaCl (Exp. I).
3. During 4½ months in the fall and winter, captive antelope ground squirrels given food and distilled water *ad libitum* gained over 20 per cent in weight. (Exp. II).
4. Even when starting from initially high weights, the squirrels maintained their weight on 0.4 molar NaCl (Exp. III).
5. When starting from initially high weights they lost weight on 0.8 molar NaCl (Exp. III).
6. During a 37-day acclimation period on 0.4 molar NaCl, those animals which had lost weight on 0.8 molar, gained weight, and those which had held constant on 0.4 molar, gained weight slightly but insignificantly (Exp. IV).
7. Animals acclimated to 0.4 molar NaCl do not lose weight significantly when placed on 0.8 molar (Exp. V).

8. Although in each experiment the consumption of solution was smaller at the higher molarity, the amount of salt ingested was greater at the higher molarity. The difference in amount of NaCl ingested at the two molarities was smallest in the freshly captured animals.
9. The animals tended to drink less after they had gained weight and become acclimated to NaCl ingestion.

Antelope ground squirrels can obtain considerable water even from a 1.0 molar solution of NaCl. As shown in Table 2, the rate of weight loss when water is withheld is three times greater than when 1.0 molar NaCl is available.

DISCUSSION

Salt metabolism has been studied in several desert rodents: *Perognathus* (Schmidt-Nielsen *et al.*, 1948), *Dipodomys* (Schmidt-Nielsen *et al.*, 1948; the Schmidt-Nielsens, 1950; Nichols, 1949), and *Gerbillus* (Burns, 1956) and some of the literature on kidney function in the white rat offers an additional comparative basis for evaluating our data. Richter and Mosier (1954) reported that white rats required 50 to 60 cc. of water per gram of NaCl ingested, which is equivalent to drinking a 0.29–0.34 molar solution. This agrees nicely with Adolph's observation (1943) that white rats can maintain themselves on half sea water, but not on more concentrated solutions.

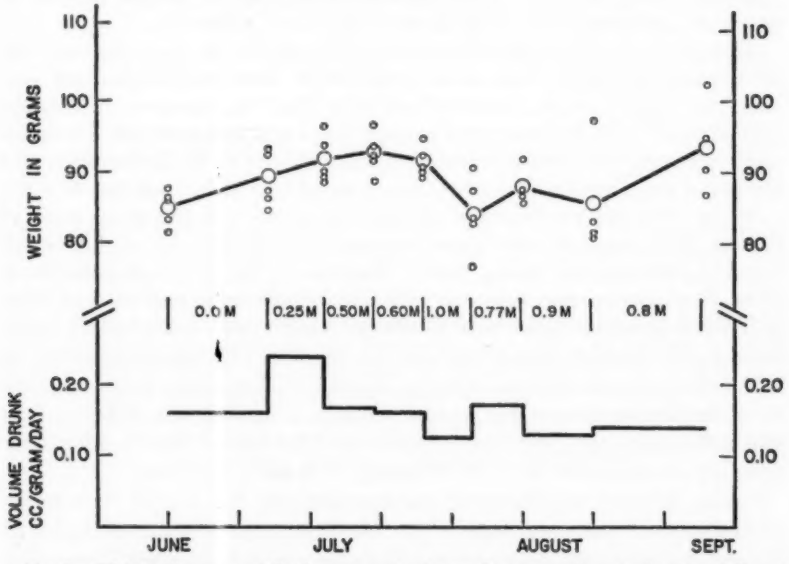

FIG. 2.—Weight changes and fluid consumption in antelope ground squirrels given different concentrations of NaCl. The small circles represent individual measurements and the large circles represent the means for each group. The lower line represents mean daily consumption for all animals on each solution.

TABLE 2.—*Effects of 1.0 molar NaCl and complete water deprivation on mean body weight*

N	INITIAL WT.	FINAL WT.	PER CENT CHANGE	DAYS	PER CENT CHANGE PER DAY	REMARKS
12	92.7	84.3	9.06	11.5	0.79	1.0 molar NaCl drinking solution
8	83.7	64.9	22.5	9	2.5	Water withheld

The only mammal previously known to be capable of effectively using sea water is the kangaroo rat, *Dipodomys merriami* (the Schmidt-Nielsens, 1950), which maintained weight on a high protein diet and the equivalent of 0.545 molar and 0.585 molar NaCl. In the present study freshly captured antelope ground squirrels maintained their weight and, after acclimation to a salt regimen, gained weight on 0.8 molar NaCl, which is about 1.4 times as saline as sea water. Moreover, the rate of decline in body weight of the squirrels when given 1.0 molar NaCl was much less than when water was withheld completely, indicating that they were obtaining water from this extremely concentrated solution. It thus appears that the antelope ground squirrel can use salt solutions almost three times as concentrated as those which can be handled by the white rat, and that the efficiency of its execretory system in processing NaCl may be greater than that of the kangaroo rat. Preliminary measurements show that antelope ground squirrels during dehydration can produce urine with an osmotic pressure in excess of 3,500 milliosmols, 1,200 of which are due to electrolytes.

Adolph (1943) found that the tolerance of white rats to sea water could not be increased by having them drink progressively more concentrated salt solutions. In sharp contrast, however, we found that the tolerance of antelope ground squirrels to high concentrations of NaCl was increased either by gradually increasing the salinity of their drinking solutions or by placing them on a prolonged regimen of a moderately concentrated (0.4 molar) solution of NaCl.

When white rats are forced to eat diets containing salt and given water *ad libitum*, the amount of water drunk increases directly with the amount of salt ingested (Richter and Mosier, 1954). However, when given salt solutions to drink, fluid consumption increases with salinity only up to molarities of 0.2 or 0.25, and decreases at higher concentrations (Adolph, 1943; Adolph *et al.*, 1954). Drinking by antelope ground squirrels also increases with increasing salinity to 0.25 molar and then declines. There is, therefore, no reason to believe that the thirst mechanism of antelope ground squirrels is qualitatively different from that of the white rat. The primary adaptation of this squirrel for obtaining water from salt solutions must lie in the efficiency of its salt metabolism.

Under different conditions of water availability the weight of antelope ground squirrels is conspicuously labile. They can stand dehydration of 20 to 25 per cent of field weight and can regain this weight in 48 hours when given water. Under laboratory conditions, with food and water available, usually they slowly gain to a level about 20 per cent over field weight. The ability to undergo dehydration without harm and to establish water credit (in terms of increased

weight) frees them of dependence on continuously available water even though they cannot survive without some water to supplement that produced by oxidative metabolism.

Antelope ground squirrels do not appear to hibernate or aestivate (Johnson, Bryant, and Miller, 1948), although they are less conspicuous above ground in the winter than at other seasons. They show no special thermo-regulatory capacities but can endure hyperthermia at least to 42.4°C. without ill effects (Dawson, 1955). Like *Citellus tereticaudus* (Vorhies, 1945) they avoid excessive heat by resorting to shade and burrows, by climbing into shrubs, and by concentrating their above-ground activity in the morning and late afternoon.

Since they cannot survive in the laboratory without succulent food or water, under natural conditions they must acquire water from vegetation or from animal food. In the laboratory they may become cannibalistic and they also kill and eat other rodents. The importance of succulent food in their diet is obvious. We have often seen them eating carrion along desert roads. They often become particularly abundant near irrigated fields. The closely related form, *Citellus nelsoni*, is primarily insectivorous during summer and fall (Hawbecker, 1947).

The physiological data presented in this paper together with the field observations discussed above allow a partial understanding of the way in which this small diurnal mammal meets the severe demands of the desert environment. Survival under natural conditions apparently depends on tolerance of dehydration, production of extremely hypertonic urine, tolerance of moderate hyperthermia, avoidance of excessive heat stress, and utilization of succulent foods.

ACKNOWLEDGMENT

These studies were aided in part by a contract between the Office of Naval Research, Department of the Navy, and the University of California (NR 160 171).

SUMMARY

The antelope ground squirrel, a common diurnal rodent in desert and semidesert areas of western North America, cannot survive on metabolic water alone. In the laboratory its mean water consumption is about 12 per cent of body weight per day. It maintains weight indefinitely while drinking 0.8 molar NaCl (1.4 times as saline as sea water) and can extract sufficient water from 1.0 molar NaCl to extend survival many days. This capacity to utilize concentrated salt solutions exceeds that of any other mammal so far studied. Prolonged ingestion of NaCl increases ability to maintain weight while drinking salt solutions. Fluid consumption is greatest on 0.25 molar NaCl and decreases with higher molarities.

Survival under natural conditions apparently depends on tolerance of dehydration, production of extremely hypertonic urine, tolerance of moderate hyperthermia, avoidance of excessive heat stress, and obtaining moisture from food to supplement metabolic water.

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THE CARNIVORES AND UNGULATES OF THE WICHITA MOUNTAINS WILDLIFE REFUGE, OKLAHOMA

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During the more than fifty years since the establishment of the Wichita Mountains Wildlife Refuge, much information, both published and unpublished, has been recorded concerning its larger mammals. This report attempts to bring this information together before an expanding civilization completely closes in around the area.

Grateful acknowledgment is extended to the members of the U.S. Fish and Wildlife Service, who have critically read the manuscript and offered helpful suggestions. Refuge files have been available, including a 1935 report by Vernon Bailey on the mammals of the Wichita Mountains, which has been cited many times in this report; the notes of two biologists, Charles H. Rouse and Frank B. McMurry, who were stationed on the Refuge from 1938 to 1942; and records left by former Forest Supervisors have been helpful. The supervisors include the late Frank Rush, Sr., the late Harry B. French, and Alan A. McCutcheon. Former Forest Ranger Earl Drummond, now retired, answered many questions concerning the early days of the Refuge. Former Refuge Manager Ernest J. Greenwalt, his successor, Julian A. Howard, and the entire Refuge staff helped to clarify many obscure data.

The Wichita Mountains Wildlife Refuge consists of 59,020 acres located within the granitic mountains of Comanche County, Oklahoma, in the Wichita Mountains Biotic District (Blair, 1939). In 1901, when the Apache, Comanche and Kiowa Reservation was opened to settlement, this tract was made a Forest Reserve under the Department of the Interior. In 1905, jurisdiction was changed to the Department of Agriculture. By authority of a proclamation by President Roosevelt on June 2, 1905, based upon a special act of Congress of January 24, 1905, the Reserve was further designated a National Game Preserve. On March 4, 1907, all forest reserves were renamed National Forests; thus the location in the Oklahoma Territory became the Wichita National Forest and Game Preserve under the direction of the U.S. Forest Service. In 1935, the Forest came under the jurisdiction of the Biological Survey of the Department of Agriculture. At present, it is administered by the U.S. Fish and Wildlife Service, Department of the Interior, as one of the national wildlife refuges under the name Wichita Mountains Wildlife Refuge.

Under administration of the Forest Service the bison, and later longhorn cattle, were kept in a central "buffalo pasture" of approximately 8,000 acres. The acreage outside this well-fenced pasture was grazed by cattle. Grazing was permitted throughout the year in the 1920's, but during the 1930's this was reduced to 5, 6 or 7 months. Horses as well as cattle were allowed on the area during the early years, but by the mid-twenties only a few saddle animals remained. In 1937 all cattle permits were cancelled.

Table 1, compiled from records in the Refuge files, shows comparative numbers of domestic stock and bison from 1906 to 1937. The figures are yearly estimates, made at the time, and are believed to be conservative, especially for cattle.

TABLE 1.—*Domestic livestock and bison numbers, 1906–1937.*

YEAR	LIVESTOCK	BISON
1906	5,000	None
1907	5,000	15
1910	5,000	17
1915	4,700	52
1920	4,500	119
1925	3,510	173
1930	2,514	247
1935	2,150	362
1937	1,083	416

Since domestic livestock were eliminated from the range in 1937, a moderate increase in both bison and longhorns has been permitted. A stout fence, encompassing practically the entire refuge, was completed in 1938 and both bison and longhorns were transferred into a 30,000-acre pasture in the northern part. Recently, some animals have been released into the southern part of the area, which is open to the public.

Chase *et al.* (1956) have concisely outlined the geology of the Wichita Mountains. The boundaries of the refuge lie completely within an uplifted area, the weathered igneous core of Precambrian age of a mountain system from which later strata have been eroded away. Elevations range from 500 to 1,400 feet above the surrounding plains.

The mountains lie at the western limit of the eastern forest districts. Upland slopes are dominated for the most part by postoak (*Quercus stellata*), blackjack oak (*Q. marilandica*) and eastern red cedar (*Juniperus virginiana*). Stream borders support American elm (*Ulmus americana*), black walnut (*Juglans nigra*), pecan (*Carya illinoensis*), white ash (*Fraxinus americana*), Chickasaw plum (*Prunus angustifolia*) and other trees and shrubs. Remnant stands of a maple believed to be *Acer grandidentatum* are found in spots on north slopes or high saddles where moisture conditions are favorable.

The grasslands are typical of the Mixed-grass Plains Biotic District (Blair and Hubbell, 1938) and are "essentially an area of transition from tall-grass prairies of the east to the short-grass plains of the west. . . ." Dominant species on the better sites include big and little bluestem (*Andropogon furcatus, A. scoparius*), Indian grass (*Sorghastrum nutans*) and switch grass (*Panicum virgatum*). Where thinner soils prevail, buffalo grass (*Buchloe dactyloides*) and several species of gramas (*Bouteloua* spp.) occur. More than 447 species of flowering plants, of 248 genera and 75 families, have been identified from the area (Eskew, 1938).

Intrusions over periods of thousands of years have produced a maze of fracture lines in the igneous rocks. In many places soils are deeper and moisture greater along these lines. This provides for more luxuriant plant growth and frequently enables trees to become established. The result, in terms of animal habitat created, is a large amount of "edge" for the area.

During the 1930's the Civilian Conservation Corps constructed 22 lakes and scores of small ponds on the refuge. These bodies of water total 636 surface acres, and are a major factor in animal distribution, as all streams in the refuge are intermittent.

The climate of the Wichita Mountains is of the continental type, with temperature extremes of –16° to 112°F., and a growing season that averages 203 days (Wahlgren, 1941). The annual rainfall averaged 29.01 inches from 1931 to 1955, and the recorded all-time extremes are 57.51 and 15.07 inches.

ORDER CARNIVORA

Canis latrans frustror Woodhouse.—The southeastern coyote approaches the western limit of its range in the Wichita Mountains. Sixty-nine coyotes from this area were examined by Young and Jackson (1951: 275) in making their determination of subspecies. From 1921 to 1950, inclusive, 2,178 coyotes were taken on the refuge. The maximum take for one year was in 1944, when 85 males and 79 females were removed. Crabb (1925) reported on the weights of seven male strychnine-killed coyotes taken in January and February, 1917. The weights ranged from 26.50 to 33.75 pounds, with the average being slightly in excess of 30.60.

A series of 65 coyote stomachs taken between 1937 and 1940 from the Wichita Refuge was examined by Charles C. Sperry in 1940. The majority were taken during the colder months.

Forty-eight of the stomachs contained food. The food items are listed in Table 2 by percentage of occurrence. Debris obviously swallowed after the animals were trapped was not counted.

As no sheep or chickens, and only a few horses, were on the refuge at that time, it is evident that some of these animals were ranging beyond the refuge boundary. The "cow" remains may have been longhorn. The absence of bison and elk is noted.

A 1926 report from Supervisor Shankling stated that in 1925 coyotes gained access to an enclosure where pronghorn antelope were kept and destroyed three of them.

Published reports on parasites from coyotes of the Wichita Mountains are those of Self and McKnight (1950) and Ellis (1955).

TABLE 2.—*Food items in stomachs of 48 coyotes, 1937–1940*

ITEM	%, TO NEAREST 0.1
Jack rabbit and cottontail	18.5
Carrion	8.2
Deer	5.2
Cow	6.2
Horse	2.1
Domestic sheep	4.1
Skunk, striped and spotted	3.1
Mole, *Scalopus*	2.1
Rodents (cotton rats, etc.)	8.2
Chicken	3.2
Wild turkey	3.1
Non-game birds	4.1
Reptiles, fishes, amphibians	2.1
Invertebrates (insects and other)	16.5
Persimmon	4.1
Prickly pear cactus	1.1
Other vegetable and misc.	8.1

Canis lupus nubilus Say.—The plains wolf is extinct on the refuge. Stanley P. Young (pers. comm., 1954) wrote concerning wolves taken in the Wichitas, "our records show two juveniles, a male and a female, taken July 4, 1906 by Vernon Bailey, and one adult male taken July 3, 1906 by A. S. Wells and one female taken March 10 by Frank Rush."

In his 1930 Fish and Game Report, Supervisor Harry French wrote, "Two timber wolves have been seen on the Forest this season, the first to my knowledge in years. . . . The only known loss is that of a calf killed in the main buffalo pasture. . . .

"One wolf of this type was killed on Post Oak Creek near the southwest corner of the Forest. Ranger Drummond saw the hide and said that there was no question about it being a timber wolf."

In his December 17, 1935 report, Vernon Bailey wrote in part, "There is some doubt as to whether the gray wolf is still present in the Wichita country. In 1933 Mr. French shot one and wounded another but others who have been riding the range have not seen them for many years."

Canis niger rufus Audubon and Bachman.—The Texas red wolf reaches the western edge of its range in the Wichita Mountains. Most of the canids present on the refuge are coyotes, but the situation is clouded by the local custom of calling everything larger than a small coyote a wolf. In its 1936 biennial report, the Oklahoma Game and Fish Commission did not list Comanche County as one of the 24 Oklahoma counties that contained wolves.

Bailey (*loc cit.*) commented, "Some of the coyote tracks were very large and suggest the big southern form (Texas red wolf) which occurs in Texas and southward. This may also account

for the wolf reported here but we have not been able to solve the problem. . . ." Young (pers. comm., 1954) stated of wolf specimens from the refuge in the Biological Survey Collections, "The red wolves, *Canis niger rufus*, are two males, one taken August 15, 1940, by Frank B. McMurry; the other taken July 6, 1940, by Chas. H. Rouse."

Vulpes fulva regalis Merriam.—If prairie red foxes are now found in the Wichita Mountains they are extremely rare. Available records reveal nothing definite. Bailey (*loc. cit.*) commented, "In 1934 the Forest Service reported eight red foxes taken by trappers on the refuge. But we have not been able to find traces of foxes of any kind."

There are persistent but unauthenticated local reports that army personnel at nearby Fort Sill have imported and released red foxes. The specimens reported in the past may be from this source. If so they probably belong to another subspecies than *regalis*, which is the red fox of north-central Oklahoma.

Urocyon cinereoargenteus ocythous Bangs.—Bailey (*loc. cit.*) reported, "No gray foxes have been reported on the Wichita Refuge for some years and those who know most about the wildlife here, think that there are none present. Formerly they were common in this rocky country and it seems strange that they could be so completely cleaned out." No other early records of this fox are now to be found. Refuge Manager G. E. Mushback stated that in April, 1937, trapper Campbell captured a gray fox. This was believed to be the first record for the refuge, and the animal was photographed and released. During a 12-month period ending June 30, 1939 only one fox was taken along with 62 coyotes. In late 1947, 23 foxes were taken in a 4-month period that also netted 54 coyotes. In 1948, Refuge Manager E. J. Greenwalt stated that foxes had increased "in the last three years" and that prior to that they were rare.

During live-trapping operations from July, 1956 to February, 1957, undertaken to reduce the number of raccoons in the public campgrounds, 17 foxes were taken in 694 trap-nights.

Sperry examined two fox stomachs from the refuge. One dated December 28, 1937 contained rabbit fur, a trace of lepidopterous pupa and a ground beetle (*Calosoma*). A fox taken July 26, 1939 was found to have eaten 12 camel crickets (*Ceuthophilus*), two other orthopterans (Acrididae), a deer mouse (*Peromyscus*), and also a trace of a ground beetle (Carabidae). On August 20, 1956, a full-grown turkey gobbler was killed and partly eaten by a fox in the refuge headquarters area. No other instances of fox predation on game species have been reported.

The recent increase in gray foxes is attributed by local people to introductions on the Fort Sill Military Reservation. Inquiry at Fort Sill failed to confirm this matter. While this may or may not actually be the case, Bailey's comment on the previous occurrence of the species seems to indicate that it has recently emerged from a protracted period in which the population was depressed to a very low level.

Euarctos a. americanus Pallas.—No specimens of the black bear from the Wichita Mountains are known to exist. A 1909 U.S. Forest Service photograph of a young black bear on West Cache Creek at the headquarters area has been published (Halloran, 1956). The last bear actually seen by Supervisor Frank Rush was in the Sunset Peak area in 1915. Ranger Earl Drummond killed a bear in 1910 on Crater Creek just south of the refuge boundary. The last record in the annual Forest Service game tabulations was in 1934, when four were listed. Bailey (*loc. cit.*) stated, in part, "The early settlers reported bear as common here many years ago and four were killed in 1934." Efforts to clarify this report have not been successful. No bears are found on the refuge at the present time.

Procyon lotor hirtus Nelson and Goldman.—Raccoons are very common, and are persistent nocturnal visitors to the campgrounds where they feed on refuse left by campers. From 1923 to 1934, inclusive, 962 raccoons were taken by local trappers under permit. The largest annual catch was 119, the smallest 44.

A live-trapping program was begun in 1945 and still continues. During the period 1945 to spring, 1957, 1,065 raccoons were transported from the refuge to other parts of Oklahoma. The largest seasonal take was during the 1956–57 season, when 400 were secured. All taken since August 9, 1955 have been weighed. The heaviest male weighed 26.5 pounds, the heaviest

female 19 pounds. The Oklahoma Game and Fish Department conducted most of the transplanting, supplemented on a small scale by local coon-hunter associations.

Self and McKnight (1950) and Ellis (1955) have published on their examinations of a few raccoons from the refuge for parasites.

Mustela vison letifera Hollister.—No one has trapped mink on the refuge since the days of the Forest Service administration, and no sight records have been recorded since that time. The report of H. P. Foley, of Cache, to the Forest Supervisor for the month of December, 1933 listed "2 minks" (*sic*). Incomplete records also reveal that in January, 1954 Foley trapped another mink, and Ed Chandler trapped two. Bailey (*loc. cit.*) comments, "A few mink tracks have been seen along the streams and lake shores and five mink skins were reported by the trappers in 1934. This is not very good mink country and probably the animals would never become very common even under complete protection." The lack of any current records bears out his prediction.

In the absence of specimens we have followed Blair (1939) in assigning the mink of western Oklahoma to the race *letifera*.

Taxidea taxus berlandieri Baird.—Bailey (*loc. cit.*) stated, "One badger was reported by the Forest Service in 1934 but none of the people here have ever seen one and do not know what they are like." Rouse in his January, 1939 report, recorded a badger secured by Federal Trapper Pickens near Meers in rolling ranch country just north of the refuge. In early 1947 two badgers were released from coyote traps on the refuge, and were listed in the report as "infrequent refuge visitors." Badger sign was reported at the old prairie dog town near Grace Mountain. Federal Trapper G. L. Rexroat found badgers common in less rocky soils 7 or 8 miles north of the refuge in 1955. He stated that these animals "thinned out" as the mountains were approached. A hole, possibly made by a badger, was found in the flat near East Sugar Creek Spring in the northwest part of the refuge in 1956. No actual records have been made since 1954. Ellis (1955) reported on parasites from a badger he trapped on the refuge in 1950.

In 1941, three badgers were released on the refuge. A male came from the Fort Sill Game Farm, a female from the Tulsa Zoo, and a third, sex unrecorded, was trapped in northern Oklahoma.

We have followed Blair (1939) in tentatively assigning the badgers of western Oklahoma to the race *berlandieri* although the possibility exists that a mixed race is present on the refuge as a result of introductions.

Spilogale interrupta Rafinesque.—Howell (1906) listed four specimens of the prairie spotted skunk from Mount Scott. He stated, "Specimens from the Wichita Mountains, Oklahoma, are intermediate in skull characters between *interrupta* and *putorius*. Externally they agree with *interrupta*."

Records of the District Forester's Cumulative Statistics provide the best available chronological record of spotted skunk numbers on the refuge, although they differ in some minor details from other material in the files. In the period 1923–34, 507 *Spilogale* were trapped on the refuge. The greatest number in one year was 75 in 1925. None was taken in 1933. Bailey (*loc. cit.*) stated, "Twenty-seven of these little skunks were taken in 1934 and we have not been able to find a single track of evidence of their presence on the refuge." McMurry mentions making up a specimen in his December, 1938 report, and in his annual report for fiscal year 1939 mentioned three that were received from Fort Sill. The mammal collection at Oklahoma State University contains the skin of a spotted skunk killed on the road at the foot of Mount Scott in 1952.

These small carnivores are still very uncommon. During the period from July 26, 1956 to February 10, 1957, only two spotted skunks appeared in live traps set for raccoon. These were released. They were caught at the base of Mount Scott, which seems at present to be the center of abundance for this species in the area.

Self and McKnight (1950) and Ellis (1955) have reported on parasites of this species. Rouse and McMurray in 1940 reported six skunks covered with lice. However, the record is not clear as to whether these were spotted or striped skunks.

Mephitis mephitis varians Gray.—The striped skunks of western Oklahoma have been assigned to the subspecies *varians* by Blair (1939) and others. The tail averages longer than in the eastern form, *mesomalas*, but is not as long as in typical *varians* from further west. Specimens from the refuge may be intergrades unassignable to either race.

There have been times when the striped skunk was the commonest carnivore on the refuge. During the period from 1923 to 1934, 6,575 were trapped. The lowest annual take was in 1925 when 324 were taken. The maximum take was 1,083 in 1931.

In March, 1940 refuge biologists reported a severe die-off. In 1943, Refuge Manager Greenwalt noted a slow increase in skunks "after almost total elimination of the two species . . . during a pneumonic epizootic of at least county-wide proportions." By 1954 striped skunks were again very common. During the 1956–57 live-trapping season for raccoons, 223 were taken from the traps.

Self and McKnight (1950) have published on the parasites of striped skunks of the Wichita Refuge.

Felis concolor True.—No specimens of the cougar from the Wichita Mountains are known to exist in any collection. The records for the State have been summarized by Young and Goldman (1946) and by Halloran (1957*a*). The form that originally inhabited the area cannot be determined, but according to the map drawn by Goldman (Young and Goldman, 1946) it should have been *stanleyana*.

Former Forest Ranger Drummond has stated that the last cougar in the Wichita Mountains was killed in the early 1900's. Bailey (*loc. cit.*) stated, "One of the caretakers at a camp on the Refuge, Gus McGuire, who has been in the country for some 30 years back, says that the last mountain lion he knew of being killed in the Wichitas was in 1908, although they were common in earlier years." There are no cougars reported in the available predatory animal catch records filed in the Refuge Headquarters.

Lynx rufus texensis J. A. Allen.—Blair (1939) assigned all of the bobcats of western Oklahoma to the subspecies *baileyi*. A letter from Viola S. Schantz to William T. Krummes, Assistant Regional Director, Albuquerque, dated July 14, 1955, reads in part: "*Lynx r. texensis* is the name for the Wichita Mountains Wildlife Refuge bobcat according to . . . Sturgis (p. 12, 1938) . . . and this identification is also confirmed by Stanley P. Young."

Trapping records indicate that in the period from 1932 to 1949, 24 bobcats were taken on the refuge. The last two, taken in 1944, were released. From 1944 until April 31, 1956 no bobcats were recorded on the refuge. On the latter date a young female was found dead by the road near the refuge's Turkey Creek prairie dog town. It weighed 13.75 pounds and was in good condition. The stomach contained the remains of a small bird and several *Peromyscus*. Rouse reported two males, one trapped January 13, 1938 weighing 10.85 kilograms. Its stomach was examined by Sperry and found to contain only cottontail rabbit. The other one, taken February 12, 1938, weighed 9.47 kilograms. A male taken September 25, 1939 by Claud A. Shrader, was prepared by McMurry and is in the refuge collection. A road-killed male found at the base of the south slope of Mt. Scott on October 7, 1957 weighed 16¼ pounds with standard measurements of 38, 5½, 7½ and 2⅞ (notch) inches. The skull and hide are deposited in the collection of Oklahoma State University, Stillwater.

ORDER ARTIODACTYLA

Cervus canadensis nelsoni Bailey.—According to Miller and Kellogg (1955) the elk originally found in Oklahoma was *C. c. canadensis*. The last native animal, according to notations in the refuge files, was killed by General Sheridan in 1881 on the mountain in the eastern part of the refuge that now bears his name. Bailey (*loc. cit.*) wrote, "There is some question as to the native elk that once occurred in this part of the country being identical with the Rocky Mountain subspecies or whether they were the plains elk extending down from the Dakotas and Kansas. . . ." Forest Service reports and correspondence indicate that on three separate occasions elk were released on the refuge. In 1908 one bull elk was given to the Forest by the city of Wichita, Kansas. The original source of this animal is not indicated. In 1911 five elk,

one bull and four cows, were received from St. Anthony, Idaho. In 1912 Supervisor Rush went to St. Anthony and returned with three bulls and twelve cows. The correspondence reveals that St. Anthony was the shipping point for elk taken from the herd at Jackson Hole, Wyoming. The present elk herd is descended from these 21 animals. They may safely be considered to be Rocky Mountain elk, *C. c. nelsoni*.

In 1913 there were 21 elk on the refuge, including three calves. In 1922 the herd was estimated at 125. In 1935 Taylor and Hoyt counted 222. A sale policy was adopted by the Forest Service in 1924, and the first sale was made in 1925. From 1925 to 1956, inclusive, 857 elk were removed from the range. During the last seven years an average of 34 elk per year were disposed of. During the same time an average of 12 animals died each year from natural causes, accidents, or poaching. In March, 1941, four bulls and fourteen cows were shipped to the Sierra del Carmen Mountains in Mexico. Also several elk managed to escape from the refuge several years ago when fire destroyed a portion of the boundary fence. Despite these removals, counts taken by helicopter revealed a minimum of 190 animals in 1955 and 251 in 1957.

Bugling is first heard in late August, and the young are born in May and June. The antler drop occurs in March. Antlers on a mature bull found dead on January 24, 1956 had an outside spread of 41.25 inches, tip to tip 39 inches, and a right beam length of 43 inches.

Prior to 1939 the elk were restricted to the 8,000-acre original "buffalo pasture." In November, 1939 the north fence of this enclosure was removed and bison, elk, and pronghorn were released into the present big game pasture. In 1953, four elk were removed into the southern part of the refuge, where increasing amounts of sign indicate that they are thriving, especially in the southwestern area between Sunset Campground and Charon's Garden. In 1952, efforts to herd elk with a helicopter in this area failed when the animals secluded themselves in a thicket of juniper and refused to come out.

Odocoileus hemionus (Rafinesque).—In 1929 the Oklahoma Game and Fish Department donated a pair of mule deer fawns to the refuge. The animals were kept in a small enclosure, and it was planned to release them into the Exhibition Pasture in 1930. The fate of these deer is not known, but in 1932 the Supervisor reported that the Virginia deer was the only species on the Forest.

In 1926 the Supervisor's Game and Fish Report noted that mule deer from the Kaibab Forest, Kanab, Utah, had been shipped to the State Fish and Game Preserve adjoining the refuge in the vicinity of Medicine Park. Of the 34 animals shipped at various times only 18 survived. Subsequent reports do not indicate that any ever became established.

Odocoileus virginianus texanus (Mearns).—Apparently the native white-tailed deer has never been exterminated from the Wichita Mountains. Two collected by Rouse in October, 1940 were identified by Goldman as belonging to the subspecies *texanus*.

The first account of deer made by Acting Supervisor Rush to the District Forester in Albuquerque, stated that in 1907, when the original fence around the 8,000-acre buffalo park was completed, there were about 15 deer inside the fence and 25 or 30 in the rest of the Forest. In the 1957 spring census 1,325 deer were estimated to be within the boundary fence of the refuge. Meanwhile, in 13 winter seasons (1944–57) the Oklahoma Game and Fish Department had removed 1,201 animals for release elsewhere in the state. The most productive season was 1956–57, when 324 were removed. Other factors that have restrained the population have been fence leakage, predation, car kills, poaching, and more recently legal hunting outside the refuge boundary. Hounds were blamed by Supervisor McCutcheon in 1935 as one of the most important causes of deer losses.

Rouse examined the stomach of an illegally killed buck on February 1, 1939 and found it to contain foods in the following percentages: *Smilax* leaves, 25; elm leaves and buds, 22; grass, 20; juniper twigs, 18; blackjack oak leaves, 5; pecan leaves, 2; coralberry leaves, 1; and unidentified leaves, buds and twigs, 7. He also noted after examining three other deer stomachs (presumably in 1939) that sumac and oak leaves appeared to be important food items. The stomach of a deer taken in November or December was recorded as containing entirely acorns.

Deer rut in November in the Wichitas. Most of the antlers are shed between December and late March. The fawning season is in late May and June.

Antilocapra a. americana (Ord).—The eastern edge of the original range of the pronghorn passed through Oklahoma in the vicinity of the Wichita Mountains (Nelson, 1925). A remnant band of these animals is known to have been near Hobart, northwest of the refuge, just prior to 1900. Early residents reported that pronghorns occurred in the Wichita Mountains at times. However, the native animals were extirpated before the area became a Forest Preserve.

In 1910 and 1911, 12 pronghorns were introduced into the refuge from the herd at Yellowstone National Park. By 1921 none of these remained. In 1921 and 1922, 16 animals from Alberta, Canada were brought in. None of these survived beyond 1931. Four fawns brought in from the Oklahoma Panhandle in 1937 failed to survive more than six months. The present herd was established by introductions from Roswell, New Mexico. Two introductions in March, 1938 and January, 1940 totaled 34 animals. These had increased to 71 in 1943, and by January, 1954 had decreased to 16. In March, 1956 there were 35.

Some correlation is indicated between annual rainfall and the success of the herd. During dry years, particularly if the normally wet month of May is at or below average, more fawns seem to survive. In years when precipitation in May exceeds the average, fawn survival is poor. Buechner (1950) also noted some correlation between coyote control and antelope numbers on this marginal pronghorn range.

Rouse (1941) reported on the winter foraging of the pronghorn. His report, Buechner's work, and refuge records reveal that two trees (blackjack oak and red cedar), one shrub (buttonbush), 24 forbs, and five grasses are included in the diet of the pronghorn on the refuge. The animals are confined to the big game pasture, and have restricted themselves to 19,000 acres in the northwestern part, which is the most open part of the entire area and more nearly resembles typical pronghorn habitat than the more heavily timbered sections further east.

Pronghorns rut locally in October. They tend to herd together during the winter months. Fawns are born in May. Shedding of the horns is accomplished in November.

Ellis (1955) reported on ectoparasites found on pronghorns from the refuge.

Bos taurus Linnaeus.—Longhorn cattle were brought to the refuge in 1927. According to a story in the *San Antonio Light* dated August 7, 1927, W. C. Barnes and J. H. Hutton of the U.S. Forest Service looked over 50,000 head of cattle to find typical specimens of the variety known as longhorn. Twenty-seven animals (20 cows, 3 bulls, 3 steers, 1 bull yearling) were assembled in Edinburg and Liberty, Texas, and shipped to the refuge. In 1938, disposal of selected animals by donation or sale was begun as a herd-improvement and limitation policy, and has continued to date. From 1938 through 1956, 1,003 animals were disposed of. The herd is now maintained at approximately 275 head, with the amount of the increase being auctioned every year. Selection is made for color and horn growth. Mixed colors are the rule. Stanley P. Young recalls that in order to improve the herd he sent Supervisor Harry French to Mexico in the mid-1930's to buy as nearly pure strain longhorn bulls as possible. Two were obtained.

For over 20 years it has been a policy not to feed concentrates to these cattle unless they were sick or aged. They are essentially grass-fed stock. There was a 97 per cent calf crop in 1955, and 90 per cent in 1956.

Exact measurements are difficult to secure on living animals, which is the reason that tip-to-tip measurements are given (Table 3) rather than the longer but less easily secured length along the curve. Steers grow much longer horns than either cows or bulls.

Records indicate that steers become infirm at 16 or 17 years, although there is a record of a steer living to 20 years. The oldest cow on record lived 17 years. Figures are for refuge animals only. No records are available for the many that have been sold.

Bison b. bison (Linnaeus).—Through the efforts of the New York Zoological Society and the American Bison Society a herd of bison was founded in the Wichita Mountains in 1907. On October 18 seven bulls and eight cows from distinct strains were shipped from New York to the

TABLE 3.—*Selected Wichita longhorn steer live weights and horn measurements*

AGE, YR.	WEIGHT, LB.	TIP-TO-TIP HORN MEASURE, IN.
1	620	—
2	750	—
3	1,070	—
6	1,435	—
7	1,535	—
9	2,045	—
10	1,965	74
13	1,645	50
14	1,710	53
15	1,380	58
16	1,515	68

Preserve. To this herd four bulls were added in 1940 from the Fort Niobrara National Wildlife Refuge in Nebraska. The present herd is made up of the offspring of the original 15 animals and the 1940 transplant. Doubtless bison herds ranged through the area in primitive times, but they were all eliminated decades before the Preserve was established.

The present herd is healthy and would continue to grow if not artificially held in check. To control herd size and thus protect the range a disposal program has been in effect since 1917. Under this program some animals are donated alive to zoos and other public institutions that request them, and a much greater number are sold, either alive or butchered. The first bulls were disposed of in 1917, and the first cows in 1923. By January, 1956, the herd numbered 922, and a total of 2,370 had been disposed of. The 1956 harvest was 300 head, and if the herd is to be maintained at its present level the annual disposal figure will be near 250 head.

Vaccination for brucellosis has been carried out since 1941. In 1909, two cows of the original stock died of "Texas Fever." The refuge lies just south of the northern boundary of the area that was included in the tick-eradication program of 1906 (MacKellar, 1942). Roudabush (1936) did not find any fever ticks (*Boophilus annulatus*) on 13 animals butchered in 1935.

Halloran (1957*b*) listed 1,590 pounds as the heaviest live weight of any bull butchered since 1953. Average ages to which bison may live have not been determined. "General Lawton," a bull of the original herd, was killed as an act of mercy in 1930 when he was over 25 years of age.

The rutting season for bison in the Wichita Mountains is in June and July. Calves are born in late March and early April. We know of no records of twins.

Ovis c. canadensis Shaw.—Seven sheep (2 rams and 5 ewes) were brought to the refuge from Canadian National Park, Alberta, in January, 1929. The fate of this herd is reported in some detail in the 1930 Supervisor's Report. "None of the seven mountain sheep have survived. These animals were apparently unable to adjust themselves to change in climate and general conditions over their Canadian home. Last year they seemed to do fairly well. However, as winter approached they appeared to lose flesh. Plenty of food was made available for them toward spring. They were fed kaffir corn and good bright hay, but still they seemed to lose weight. About the first of March, a ewe died and upon close examination it was found to be infested with ticks. Immediate action was taken to rid the remaining sheep, one ram and three ewes, of ticks and on March 6, they were dipped . . . A large number of ticks were found on these animals.

"The sheep were placed in the exhibition pasture following dipping and fed grain . . .

"One day toward the latter part of May only the ram was observed and the pasture was ridden out . . . and their carcasses were found where they had died a day or two before. The ram survived until near the first of July, and he too died.

"As you know, one escaped into the main buffalo pasture, jumped out from there and was killed by an unscrupulous hunter. Several months later he was apprehended, having shipped

the head and hide to a taxidermist in Texas. A substantial fine resulted but, of course, that did not replace the sheep.

"The mountain sheep did better the first spring than the second, but I feel the failure is due primarily to climatic conditions, more than from the effects of ticks or disease."

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MAMMALS OF JACKSON HOLE, WYOMING

By Norman C. Negus and James S. Findley

The field work upon which this report is based was conducted in the summers of 1948 and 1949 by both of us, and in the summer of 1956 by Negus. The base of operations was the Jackson Hole Biological Research Station near Moran, Teton County, Wyoming. The greatest part of our collections and observations were made in the northern part of Jackson Hole in the vicinity of Moran. Specimens of mammals obtained by us are preserved in the Museum of Natural History at the University of Kansas, in the Zoology Department of Ohio State University, in the Tulane University Zoological Collections, and in the University of New Mexico Collection of Vertebrates. Our studies were supported by grants-in-aid from Jackson Hole Biological Research Station and from the Tulane University Council on Research. We wish to express our thanks to James R. Simon, former director of the Station for much assistance and advice and for making available to us his notes on mammals in the Jackson Hole area.

Jackson Hole is a mountain valley in northwestern Wyoming. The valley is nearly surrounded by natural barriers, namely the Teton Range on the west, the Gros Ventre Range and Mount Leidy Highlands on the east, the Snake River Range on the south, and the Yellowstone Plateau and Absaroka Range on the north and northeast. The valley lies on a north-south axis, is approximately 35 miles in length and varies in width from 3 to 10 miles. The valley floor slopes gently upward from south to north, from 6,000 feet at its southern end to 6,745 feet at Moran.

The major plant communities in Jackson Hole and environs include an extensive area of sage and grass, which covers most of the valley floor, and a lodgepole pine-Douglas fir forest which covers the slopes of the surrounding foothills and occasional small hills and other elevated areas in the midst of the sage-grass community. An Engelmann spruce-alpine fir-whitebark pine community occurs on northern and eastern slopes and is particularly well developed at altitudes between 9,000 and 10,000 feet above the pine forest. Areas of alpine tundra are found on the tops of the higher mountain masses, usually at elevations above 10,500 feet. Certain seral communities are prominent in some of these vegetation types. For example, hydrosere communities of grasses and sedges, or of grasses, sedges and willows, are a prominent part of the landscape in the Moran area. We refer to the latter vegetation type as willow savannah. Stands of aspen (*Populus tremuloides*) form subclimax communities in certain areas. In drier clearings in the spruce-fir and pine forest occur meadows of various short annual grasses and forbs.

We sampled the small mammals in most of the major plant communities by snap- and live-trapping. In most of these habitats we operated at least one quadrat. These quadrats consisted of a delimited square 150 feet on a side. In each were set the number of traps which in our judgment assured most efficient removal of the population of small mammals. These trapping units were operated

for three nights, and the total three-night yields of animals from each quadrat were used as a basis of comparing mammal populations in the various habitats. Standard traplines were used to sample habitats in which quadrats were not used and to supplement data from quadrats. Locations and descriptions of 17 half-acre quadrats are as follows: (1) Sage-grass community, 7 mi. S Moran; (2) locality and community as in No. 1; (3) grass-sedge meadow with some standing water, Moran; (4) sage community, 4 mi. S Moosehead Ranch; (5) lodgepole pine forest, 2 mi. S Moran; (6) willow-grass savannah, Moran; (7) aspen subclimax, near Two Ocean Lake; (8) forb-grass meadow, near Two Ocean Lake; (9) aspen subclimax near Emma Matilda Lake; (10) alpine meadow, above timberline on Brooks Mountain; (11) sage-grass community, 5 mi. S Moran; (12) willow-grass savannah, Moran; (13) dry timothy meadow, Moran; (14) same as No. 10; (15) same as No. 14; (16) aspen subclimax near Wildlife Park Information Office; (17) spruce-fir-whitebark pine community near Togwotee Pass. Total three-night catches from these quadrats are shown in Table 1.

ACCOUNTS OF SPECIES

Sorex c. cinereus Kerr. Cinereous shrew.—All of our specimens of this shrew have been taken in hydrosere communities in the vicinity of Moran. Willow-sedge savannahs and wet grass-sedge meadows seem to be the favored habitat of these animals. We captured none in other communities. In the three quadrats in which this species was taken (two quadrats in willow savannah and one in a wet grass-sedge meadow) no other species of *Sorex* was taken. In a trapline along a stream bordered by willows and sedges near Moran, five *S. cinereus* and nine *S. vagrans* were captured. The commonest mammalian associate of *S. cinereus* in this area is *Microtus pennsylvanicus*.

Other records of the occurrence of this species in the Jackson Hole area (Jackson, 1928: 50) are: Emma Matilda Lake; Pacific Creek; Moose Lake; Teton Pass, above Fish Creek, 7,200 ft.

Sorex nanus Merriam. Dwarf shrew.—One record of this species in the Jackson Hole area has been provided by Durrant and Lee (1955: 560–561). This animal was found dead in the snow on a rocky tundra above timberline at 10,050 feet, at South Cascade Canyon, Grand Teton National Park, on July 8, 1952.

Sorex vagrans obscurus Merriam. Wandering shrew.—This shrew was taken by us in a far greater variety of habitats than was the cinereous shrew. In the aspen community and among willows along a stream near Moran, *S. vagrans* was especially common, but specimens were also obtained in the sage-grass community, in lodgepole forest, in grass-forb meadows, in a timothy meadow, in grass-sedge meadows, and in wet meadows and spruce-fir forest at Togwotee Pass. The wandering shrew thus seems capable of existing in more xeric habitats than the cinereous shrew. While *S. cinereus* is often found in company with *Microtus pennsylvanicus*, *S. vagrans* is more often associated with *M. montanus*.

Records of occurrence of this species in the Jackson Hole area (Findley, 1955: 46) are: Two Ocean Lake; Emma Matilda Lake; 1 mi. N Moran; 2½ mi. E and ¼ mi. N Moran; Beaver Dick Lake; Moose Creek, Teton Mts.; Teton Pass above Fish Creek; Whetstone Creek; Flat Creek-Gravel Creek divide; Flat Creek- Granite Creek divide; Jackson; Togwotee Pass.

Sorex palustris navigator Baird. Water shrew.—Four water shrews obtained by us were captured along a small stream bordered by willows, grasses and sedges in the vicinity of Moran. One adult male was taken 2 miles west of Togwotee Pass at an altitude of about 9,200 feet at a streamside feeding station of *Microtus richardsoni*. The average number of embryos in three pregnant females collected in July was 4.7 (range: 3–6).

Records of the occurrence of this species in the Jackson Hole area (specimens in the University of Michigan Museum of Zoology) are: Jackson; Whetstone; Beaver Dick Lake. Capture

localities recorded by Jackson (1928: 189) are: Emma Matilda Lake; Moose Creek, Teton Mts.; Pacific Creek; Fish Creek, above Teton Pass.

Myotis lucifugus carissima Thomas. Little brown bat.—Roosts inhabited by large numbers of bats of this species were located in Moran, in a chapel one mile south of Moran, and at JO Ranch. The adult individuals in these roosts were all females which, in June, were pregnant, and in early July were accompanied by young (Findley, 1954). In the evening little brown bats were shot over a backwater of the Snake River 1½ miles east of Moran, over a pasture in an aspen grove near Moran, and over Two Ocean Lake. Although we shot a number of bats over a water hole in the sage-grass community, none was *M. lucifugus*. This seems to indicate that the species prefers forested areas in Jackson Hole.

Myotis volans interior Miller. Hairy-winged bat.—Fourteen of these bats were obtained 14 miles north of Blacktail Butte over a water hole in the sage-grass community and in an abandoned log cabin in the adjacent lodgepole pine forest. The specimens from the cabin were taken during the night when they entered the building to roost. No bats were found in this building in the daytime. Pregnant females were obtained on July 11 and July 13.

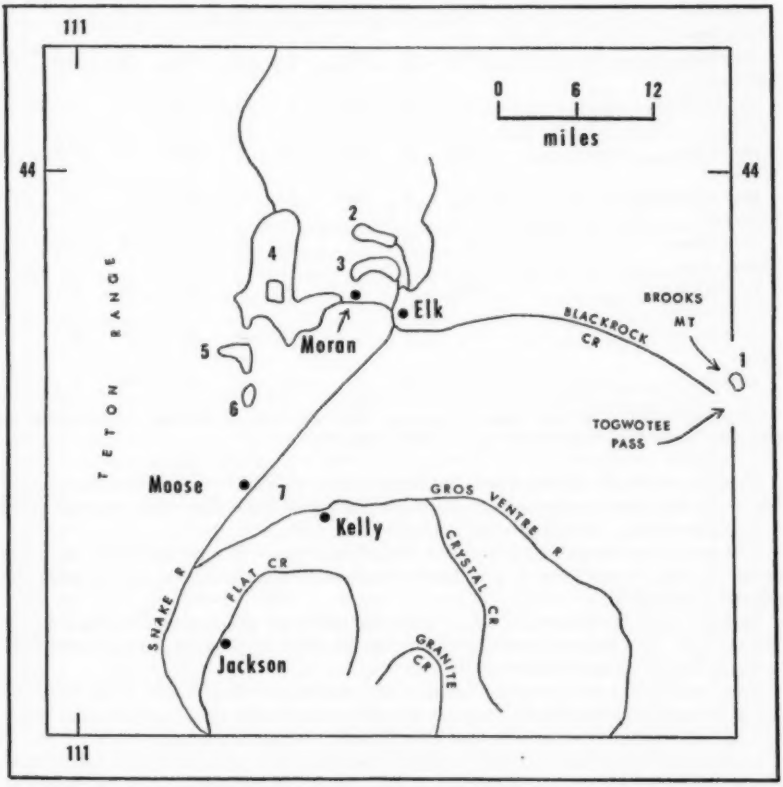

FIG. 1.—Map of the Jackson Hole area, northwestern Wyoming. Certain features are indicated by numbers as follows: 1. Brooks Lake; 2. Two Ocean Lake; 3. Emma Matilda Lake; 4. Jackson Lake; 5. Leigh Lake; 6. Jenny Lake; 7. Blacktail Butte.

TABLE 1.—*Number of mammals obtained in half-acre quadrats*

SPECIES	SAGE (4)*	GRASS-SEDGE MEADOW	WILLOW SAVANNAH (2)*	TIMOTHY MEADOW	GRASS-FORB MEADOW	ASPEN (3)*	LODGEPOLE FOREST	ALPINE MEADOW (3)*	SPRUCE-FIR-WHITEBARK PINE FOREST
Sorex cinereus	0	1	2	0	0	0	0	0	0
Sorex vagrans	0.8	0	0	1	1	3.7	1	0	1
Eutamias minimus	1.5	0	0	0	0	0	0	0	0
Thomomys talpoides	3.5	0	0	1	2	3	0	0.3	0
Peromyscus maniculatus	3	0	0	0	0	1.7	0	1.6	7
Microtus montanus	0.5	1	1	9	6	2.3	0	15.6	0
Microtus pennsylvanicus	0	4	6.5	1	0	0	0	0	0
Microtus richardsoni	0	0	0	0	0	0	0	4.6	0
Phenacomys intermedius	0.8	0	0	0	0	0	0	0	0
Clethrionomys gapperi	0	0	1	1	0	0	0	0	4
Zapus princeps	0	0	0	3	2	2.3	0	0	0

* Parenthetical figures indicate number of quadrats, where more than one represent a given habitat. In these cases, figures in the column below represent the average yield.

Myotis e. evotis (H. Allen). Long-eared bat.—Three of these bats were shot over a water hole in the sage-grass community 14 miles north of Blacktail Butte. Here they were associated with *Myotis volans*. None was found in day or night roosts.

Lasionycteris noctivagans (LeConte). Silver-haired bat.—One of these bats was shot along the Gros Ventre River in a cottonwood-willow community on August 11, 1948. No others were obtained.

Lasiurus cinereus (Beauvois). Hoary bat.—We are aware of one record of this bat from Jackson Hole. This specimen was obtained on July 20, 1939, by W. T. McKean at Leigh Lake in Grand Teton National Park.

Ursus americanus cinnamomum Audubon and Bachman. Black bear.—Black bears are rather common in Jackson Hole. They are most often observed in the vicinity of public camp grounds, although their tracks are often seen along the streams of the area.

Ursus horribilis ssp. Grizzly bear.—Grizzlies seem to be rare in Jackson Hole. According to James R. Simon, a few are found north of Moran. He reports one killed in this area (Arizona Creek) on May 8, 1948, by Taylor and Steingraber.

Martes americana caurina (Merriam). Pine marten.—According to reports of residents, the marten is found most commonly at higher altitudes in forests of spruce and fir. Occasionally it

is found in lodgepole pine forests at lower altitudes. According to Simon, licensed trappers take approximately 400 annually in the Jackson Hole area. On July 5, 1956, an adult male was found freshly killed on U.S. Route 287, 17 miles east of Moran.

Mustela erminea muricus (Bangs). Ermine.—We obtained 11 specimens of this weasel in willow savannahs one mile east of Moran, and one in an adjacent timothy meadow. Both were in areas occupied by *Microtus* and *Clethrionomys*.

Hall (1951: 165) records specimens from Whetstone Creek and ¼ mi. E Moran.

Mustela frenata nevadensis Hall. Long-tailed weasel.—All but one of our specimens of *M. frenata* were taken in willow savannahs near Moran. One specimen was obtained in the spruce-fir forest on the south side of Brooks Peak at an approximate altitude of 10,000 feet. Another individual was observed in the sage-grass community near Jackson. A male, taken on July 28, 1949, had mature sperm in the epididymis. In July and August males were sometimes observed pursuing females.

Hall (1951: 290) records specimens from Crystal Creek, Jackson, and Whetstone Creek.

Mustela vison energumenos (Bangs). Mink.—A juvenile female mink was obtained on July 17, 1949, at Moran. An adult was observed at Two Ocean Lake. Simon reports finding a nest of young in a pile of logs at Polecat Creek on May 23, 1948.

Lutra canadensis nexa Goldman. Otter.—Simon reports as many as six otter being taken in a winter in Jackson Hole. On April 1, 1947, he observed tracks along the Snake River near Moran.

Mephitis mephitis hudsonica (Richardson). Striped skunk.—We have observed but three skunks in the course of our work in Jackson Hole. These animals were seen near sage communities, hayfields, and in a cottonwood-willow community near water. All these stations are in Jackson Hole proper.

Taxidea t. taxus (Schreber). Badger.—This animal was observed by us only in the sage-grass community. Badgers were usually seen in the vicinity of colonies of *Citellus armatus*. A 24-pound male obtained on July 14 had mature sperm in the epididymis.

Vulpes fulva macroura Baird. Red fox.—Red foxes are uncommon in the Jackson Hole area; reports of residents confirm this observation. On July 14, 1948, in the spruce-fir-whitebark pine community at Togwotee Pass, we discovered a family of three young foxes and one adult. The young had left the den. At this station an adult fox ran through our camp within 5 feet of the fire.

Canis latrans lestes Merriam. Coyote.—Coyotes were seen by us while they were hunting in the hayfields and pastures in the vicinity of Moran. These animals were also observed near our camp in the alpine zone atop Brooks Peak, at 11,000 feet, near Togwotee Pass. At this latter station they were probably hunting *Microtus* which were common in the alpine meadows.

Young and Jackson (1951: 287) record specimens from: Jackson, Kelly, Moran.

Canis lupus irremotus Goldman. Gray wolf.—The wolf is recorded by Young and Goldman (1944: 448–449) from Elk and the vicinity of Kelly (Bacon Creek Ridge). Both localities are in the eastern part of Jackson Hole. Simon reports that in past years a wolf has been taken "every two or three years" in the Jackson Hole area.

Felis concolor missoulensis Goldman. Puma.—Young and Goldman (1946: 208) record pumas from Buffalo River, about 20 miles southeast of Jackson Lake, and from Jackson Lake. According to Simon, lions are reported in Jackson Hole every several years.

Lynx c. canadensis Kerr. Lynx.—Simon knows of three records of the lynx in Jackson Hole "in recent years." The authenticity of these records is not known to us.

Lynx rufus pallescens Merriam. Bobcat.—We examined a male bobcat which was killed on the road 5 miles west of Togwotee Pass on July 17, 1949. The specimen was an adult, but smears of the testes showed no mature sperm.

Marmota flaviventris nosophora Howell. Yellow-bellied marmot.—Marmots were most commonly observed by us on the edges of Hudsonian zone forests at timberline and in rocky alpine areas up to 11,000 feet in altitude. These animals were also seen on rocky hills, such as Uhl Hill and Signal Mt., in the floor of Jackson Hole. A family lived in the roof of Grand Teton

National Park headquarters. Melanistic marmots are observed frequently in the canyons of the Park. In 1956, a jet black adult marmot was seen on several occasions at the edge of a pasture in Moran. Howell (1915: 49) records this form at Jackson.

Citellus armatus (Kennicott). Uinta ground squirrel.—This species in Jackson Hole usually is found in sage or sage-grass communities and always, so far as our observations go, in dry situations. Many of our specimens were taken near Elk, or neighboring Uhl Hill. One specimen was obtained in a burned area in spruce-fir forest near Togwotee Pass at 9,600 feet, and a small colony was located at a somewhat lower elevation at nearby Brooks Lake. Animals of this species were also observed by us near Jackson and in the Grand Canyon of the Snake River. Howell (1938: 80–81) records this species also at Waterdog Lake, Gros Ventre Mts.

None of 21 females examined between June 27 and August 17 was pregnant. Of 17 males examined in this period none had mature sperm in the testes. In northern Jackson Hole these animals disappear in the latter half of August. In 1949, our latest sight record was on August 17. In 1956, they were last seen in the vicinity of Moran on August 14, on which date the entire local population seemingly disappeared en masse.

Citellus lateralis caryi (Howell). Mantled ground squirrel.—We obtained animals of this race only in the vicinity of Togwotee Pass where we found them on the edges of spruce-fir forests and at timberline. Females with five, six, and seven placental scars were obtained. A lactating female was taken on July 26. Two males taken July 7, and two captured on August 5, were sexually inactive.

Citellus lateralis castanurus (Merriam). Mantled ground squirrel.—Howell (1938: 202–203) records this subspecies from Jackson, from the head of Flat and Twin Creeks in the Gros Ventre Range, and from south of Moose Creek in the Teton Range. We have examined the series of ten specimens from Twin Creek and find that they differ from a series of seven animals from Togwotee Pass in darker undersides of the tails. In dorsal aspect the Togwotee specimens appear paler and grayer, but the two series are not in exactly comparable pelage. A single specimen from Sheep Mountain, just north of the Gros Ventre Range, appears to us to be closest to *C. l. caryi*.

Eutamias minimus consobrinus (Allen). Least chipmunk.—This chipmunk inhabits more ecological communities and has a greater altitudinal range than either of the other two species found in the Jackson Hole area. We took this animal commonly in sage, in and on the edges of forests of lodgepole pine, and in and on the edges of forests of spruce and fir up to timberline.

White (1953: 594), who has examined our material, records this animal from: north end Blacktail Butte; 1 mi. E Moose; Bar BC Ranch; 2½ mi. NE Moose; 3¾ mi. E Moose; 3¾ mi. E and ¾ mi. S Moran; 5 mi. S Moran; 2 mi. S Elk Ranch; 7 mi. S Moran; 19 mi. E and 2 mi. S Moran; Flat Creek Pass; Flat Creek-Crystal Creek Divide; Flat Creek-Granite Creek Divide; Dry Hollow, Jackson; Jackson; Jenny Lake; Sheep Creek, Jackson; Togwotee Pass.

Of 21 specimens examined between June 27 and August 30, no sexually active males or females were found.

Eutamias amoenus luteiventris (Allen). Yellow pine chipmunk.—The center of abundance of this species is in the aspen and lodgepole pine forests, especially where these forests are open and support a ground cover of shrubs and forbs. We also obtained these animals in sage and open forb-grass meadows, but always near the edge of the lodgepole or aspen forest. A few were taken in a mixed community of willow, grass, and sage. Seemingly the yellow pine chipmunk does not transcend the lodgepole pine belt to any extent in this area. In the spruce-fir zone this species is replaced by *E. umbrinus*.

White (1953: 603), who has examined and listed our specimens, records the form from: Two Ocean Lake; Whetstone Creek; Emma Matilda Lake; Pacific Creek Road, 2½ mi. E Moran; 2 mi. E Moran; 2½ mi. E and ¼ mi. N Moran; Pacific Creek; junction Two Ocean Lake road and U.S. Highway 187; Signal Mountain road; Leigh Lake; Indian Paintbrush Canyon, Teton Park; 3 mi. E and ¼ mi. S Moran; 3¾ mi. E and 1 mi. S Moran; 2½ mi. N and 3½ mi. E Moran; 4 mi. N Moose; Bar BC Ranch; 2½ mi. N Moose; Grand Teton; Upper Arizona Creek, Jackson; Teton Pass.

On July 7, 1949, a female was obtained containing six embryos that were visible by gross microscopic examination. This specimen was lactating. A lactating female with five placental scars was taken on July 11, and a non-lactating female with five scars was secured on August 10. The testes of a male taken on August 8 contained mature sperm. It thus seems that this species may sometimes produce more than one litter a year in this area.

Eutamias umbrinus fremonti White. Wyoming chipmunk.—We obtained animals of this species only in and around the spruce-fire forest at Togwotee Pass. Here they were most often seen on the borders of clearings and meadows in the woods. One specimen was shot while it was climbing on a cliff on Brooks Mountain well above timberline. This species is associated with *E. minimus* and *Citellus lateralis* among diurnal rodents.

Record stations of occurrence in the Jackson Hole area from White (1953: 607) are: 1 mi. E and ¼ mi. N Togwotee Pass, 9,800 ft.; Amphitheater Lake, Teton Park; Flat Creek; head of Cache Creek; Upper Arizona Creek, Jackson; Flat Creek-Granite Creek Divide; Flat Creek Pass; Flat Creek-Gravel Creek Divide; south of Moose Creek, Teton Mts.

On July 7, two lactating females, each with seven placental scars, were taken. On July 17, two lactating females were captured.

Tamiasciurus hudsonicus ventorum (Allen). Red squirrel.—Red squirrels were obtained by us on a lodgepole pine "island" in the sage, one mile south of Signal Mountain, on Signal Mountain, 2 miles north of Blacktail Butte in a pine forest, in pine forest at and near Two Ocean Lake, and spruce-fir forest at Togwotee Pass. On March 14, 1947, Simon observed an animal of this species in willows, far from coniferous forest.

We captured lactating females on July 5 and August 1. On July 13, 1949, a nest of four young approximately three days old was found in a cavity in a lodgepole pine. On August 11 a non-lactating female with four placental scars was obtained.

Glaucomys sabrinus bangsi (Rhoads). Northern flying squirrel.—We obtained this squirrel in a lodgepole pine forest 2 miles east of Moran and in a mixed lodgepole-aspen forest one mile east of Moran. In all, five specimens were taken.

A non-lactating female taken August 10 had five placental scars. Animals of the year, two-thirds grown, were captured on August 11 and August 26.

Thomomys talpoides tenellus Goldman. Northern pocket gopher.—We found this animal to be abundant in sage, forb-grass meadows, hayfields, aspen groves, subalpine and alpine meadows, and forest clearings. We found none in areas that are periodically inundated, such as willow-grass savannahs.

Specimens were obtained from the following localities: Moran; 5 mi. S Moran; 6 mi. S Moran; 7 mi. S Moran; Elk; Two Ocean Lake; Emma Matilda Lake; summit of Brooks Mountain.

Castor canadensis ssp. Beaver.—Beaver are numerous along the small streams near Moran. These animals were also observed by us along the Snake River near Moran and in a small pond on Signal Mountain. No specimens were obtained.

Peromyscus maniculatus artemesiae (Rhoads). Deer mouse.—Specimens were obtained in lodgepole forest, in spruce-fir forest, in alpine and subalpine meadows and in sage-grass communities. One animal of this species was taken in the streamside runway of *Microtus richardsoni* in a subalpine meadow at Togwotee Pass, but no others were taken in intensive trapping of various hydrosere communities. Deer mice seemed commonest in spruce-fir forest.

Record stations of occurrence are: 5 mi. S Moran; 7 mi. S Moran; Moran; Togwotee Pass; summit of Brooks Mountain.

Neotoma cinerea orolestes Merriam. Bushy-tailed woodrat.—Two specimens of the species were obtained by us on a rocky northern slope of Signal Mountain. One specimen was obtained near Grassy Lake in a talus slide. This rat was rare in 1948 and 1949, but is reported by Simon and others to have been much more abundant in 1943 (Negus, 1950*a*: 196).

Phenacomys intermedius intermedius Merriam. Rocky mountain lemming vole.—We captured four of these voles in the sage-grass community 7 miles south of Moran, two on a hillside of sage-grass just east of Moran, one in a dry subalpine meadow in the vicinity of boulders, and

two from the side of a stream in subalpine meadows in the habitat of *Microtus richardsoni*. The latter two localities were near Togwotee Pass. Although this vole was not abundant in any of the habitats studied, its distribution, as Negus (1950*b*: 351) has indicated, extends from the floor of Jackson Hole up to altitudes over 10,000 feet in the spruce-fir forests.

Clethrionomys gapperi galei (Merriam). Red-backed vole.—In the vicinity of Moran this was a common inhabitant of willow-grass-sedge communities, usually in the vicinity of small streams. Fourteen were taken in this habitat. We also took 11 specimens in the spruce-fir forest at Togwotee Pass. None was obtained in lodgepole forest, sage, or in dry meadows.

Records of occurrence (Cockrum and Fitch, 1952: 284) are: Moran; 2¾ mi. E Moran; 3¾ mi. E and 1 mi. S Moran; Togwotee Pass.

Pregnant females were obtained on June 27 (six embryos); July 6 (six embryos) and July 10 (seven embryos). Sexually active males were taken from July 6 through August 26. The smallest sexually active male weighed 14 grams. Adult weight is usually over 20 grams.

Microtus pennsylvanicus pullatus Anderson. Meadow vole.—We obtained this species commonly in hydrosere communities (grass-sedge meadows and willow-grass savannahs) in the vicinity of Moran. In drier communities and at higher altitudes the meadow vole is replaced by *M. montanus* and *M. richardsoni* (Findley, 1951).

Additional records of the species in Jackson Hole (Anderson, 1956: 99) are: Whetstone Creek; 5 mi. N Moran; Moran and environs (four localities within 4 miles of Moran); Trappers Lake, Teton Park; Jenny Lake, Teton Park; String Lake, Teton Park; Jackson and environs.

Pregnant females were obtained on July 14 and 17, containing six and four embryos respectively. Lactating non-pregnant females were taken June 28 and August 3. Sexually active males were taken on July 17, 19 and 29. The smallest sexually mature male weighed 17.8 grams. Two sexually immature males (no mature sperm in testes) weighed 11.9 and 13.4 grams. Adult weight ranges from 25 to 45 grams.

Microtus montanus nanus (Merriam). Mountain vole.—Mountain voles were captured in the following habitats: alpine meadow, subalpine meadow, lush grass-forb meadow, wet sedge meadow, willow savannah, timothy meadow, aspen forest, sage-grass community, and willow-alder streamside community. Thus this is one of the more versatile small mammals in this area from the standpoint of habitat selection. As pointed out by Findley (1951) *M. montanus* is to some extent replaced by *M. pennsylvanicus* in hydrosere communities. The densest populations detected by us were in alpine meadows.

Locality records for this animal in the Jackson Hole area from Anderson (1954: 496) are: Pacific Creek; Big Game Ridge; Whetstone Creek; Moran and environs; S fork Buffalo River; 2 mi. W pass, Black Rock Creek; Jenny Lake Bar BC Ranch, 2¾ mi. NE Moose; Teton Pass above Fish Creek; Jackson and environs; Sheep Creek.

Pregnant females were obtained on July 1, 6, 10, 11 and August 14. Embryo counts ranged from four to eight. Females with seven and eight placental scars were taken. Sexually active males were taken on July 1, 2, 11, 12, 17 and 27.

Microtus longicaudus mordax (Merriam). Long-tailed vole.—This vole has been taken by us in aspen forest, on the rocky, wooded north slope of Signal Mountain and along a small stream near Grassy Lake, in association with *Microtus richardsoni*. The long-tailed vole seems to be the least common species of *Microtus* in Jackson Hole.

Pregnant females were taken on July 27 and August 6, containing five and four embryos respectively. On August 14, a lactating female with four placental scars was captured. A sexually active male was taken on August 13.

Microtus richardsoni macropus (Merriam). Water vole.—We obtained this species along small streams in subalpine meadows near Togwotee Pass and in alpine meadows atop Brooks Mountain. At Togwotee Pass the voles were taken from moist runways along the streams and from bank burrows at or below water level. A single specimen was collected along a stream near Grassy Lake at 7,000 ft. in association with *Sorex palustris, Phenacomys intermedius* and *M. longicaudus*. Near Togwotee Pass the water voles were found associated with *Zapus princeps, Sorex palustris, S. cinereus* and *Phenacomys*. In this area *M. richardsoni* was not encoun-

tered at altitudes below 9,000 feet on the west slope of the pass despite rather intensive trapping along small streams below this altitude. The distribution of this species along small streams in the spruce-fir belt was discontinuous. Colonies seemed limited to stretches along streams that were of low gradient bordered by overhanging banks. On Brooks Mountain this species inhabited burrows and runways in the more mesic alpine grassland. Here they were associated with large numbers of *M. montanus*.

Pregnant females were taken on July 7, 15, 17, 20, 21 and August 4 and 12. The average number of embryos was six with extremes of five and nine (10 specimens averaged). Sexually active males were taken from July 15 to August 26. The smallest sexually mature male weighed 27.9 grams. The smallest pregnant female weighed 34.2 grams. Adult weights are often 100 grams or more. One pregnant female, with five embryos which measured 8.6 mm. in crown-rump length, weighed 222 grams.

Lagurus curtatus levidensis (Goldman). Sage vole.—The only known specimen of this vole from Jackson Hole was obtained by Olaus J. Murie on December 3, 1928, from Sheep Creek, near Jackson. It is preserved in the Biological Survey Collection.

Ondatra zibethica osoyoosensis (Lord). Muskrat.—Muskrats were observed by us in beaver ponds, small streams and in the Snake River near Moran. The animals seemed to be common in this area.

Mus musculus ssp. House mouse.—Three of these mice were taken in a store in Jackson. None was obtained, despite repeated efforts to secure them, in Moran.

Zapus princeps utahensis Hall. Rocky Mountain jumping mouse.—Communities from which jumping mice were obtained by us included aspen forest, lush forb-grass meadow, timothy meadow, and willow-alder thickets along a stream. These animals seemed most common in aspen groves. In 1956, jumping mice were frequently collected along small streams in the Hudsonian zone near Togwotee Pass, at altitudes from 9,000 to 10,000 feet. Here the mice were often trapped at streamside burrow entrances and feeding stations of water voles.

Record stations of occurrence are: Two Ocean Lake; Moran; 2 mi. E Moran. Krutzsch (1954: 419–420) records the species from: Bar BC Ranch; 2½ mi. NE Moose; Moose.

On July 3 and 4, three pregnant females were taken containing five, six and seven embryos. On July 4, a lactating, non-pregnant female was obtained.

Erethizon dorsatum epixanthum Brandt. Porcupine.—We observed this animal in all habitats in Jackson Hole.

Ochotona princeps ventorum Howell. Pika.—We obtained this animal in rocky areas at and above timberline on Brooks and Sublette Peaks and in small rock slides within the spruce-fir forest from Togwotee Pass down to about 9,000 feet altitude on the west slope. Near Grassy Lake they were observed in rock slides at about 7,200 feet altitude in the lodgepole-spruce forests.

Records from Howell (1924: 19) are: Gros Ventre Mountains near Jackson; Teton Range, South Moose Creek, 10,000 feet; Teton Pass.

Lepus t. townsendi Bachman. White-tailed jack rabbit.—We observed and collected animals of this species commonly in the vicinity of Kelly in the sage-grass community and in the vicinity of cultivated fields. North of Kelly the animals were less common and few were seen as far north as Elk.

Animals of the year were taken on July 12 and 13, weighing 835.3 and 909.0 grams, respectively. A lactating female taken August 3 weighed 2,984.5 grams.

Lepus americanus bairdi Hayden. Varying hare.—These hares seemed uncommon in 1948–49. We obtained a road-killed specimen one mile south of Moran in lodgepole forest, and another at Togwotee Pass. The animal obtained on July 15 contained five embryos, and that taken on August 18 was lactating.

Cervus canadensis nelsoni Bailey. Elk.—Elk are common animals in the Jackson Hole area, occupying the highlands in summer and the valley, especially the National Elk Refuge at Jackson, in winter. Our few observations add nothing to the voluminous data of Murie (1951).

Odocoileus h. hemionus (Rafinesque). Mule deer.—We observed this deer in most communities in Jackson Hole and environs.

Odocoileus virginianus ochrourus (Bailey). White-tailed deer.—This deer was formerly found in Yellowstone Park and Jackson Hole but, according to Simon, none have occurred in the latter station in recent years. They have been introduced into the Jackson Hole Wildlife Park. On February 15, 1948, nine were present. Four were killed or died in the winter of 1948–49.

Alces alces shirasi Nelson. Moose.—Moose were seen in the vicinity of ponds, small lakes and backwaters of the Snake River. We also observed them at timberline on Brooks Mountain and in subalpine meadows near Togwotee Pass. In winter they frequent lower elevations and are often reported on highways and in cleared ranchyards.

Simon has provided us with the following reproductive data. On June 3, 1948, a cow with twin calves about a day old was seen at the Wildlife Park; on the same date a calf was born at Bear Paw Ranch. On June 7, 1947, a 4-day-old calf was observed at Flagg Ranch. On January 2, 1949, a cow and calf were still in association at the Wildlife Park.

Antilocapra a. americana (Ord). Pronghorn.—Pronghorns have probably not occurred naturally in Jackson Hole for many years according to reports of residents. From time to time a few have been introduced into the Wildlife Park.

Bison b. bison (Linnaeus). Bison.—Formerly bison ranged through Jackson Hole but probably did not winter there, except possibly in the area south of Jackson (Fryxell, 1928).

At present a small herd is maintained in the Wildlife Park. We heard reports of a "renegade" herd supposed to range in the area north of the highway between Moran and Togwotee Pass.

Negus (1950*c*: 463) has reported on the reproduction of this animal in Jackson Hole.

Ovis c. canadensis Shaw. Bighorn sheep.—According to Honess and Frost (1942) bighorns are distributed in the Jackson Hole area as follows: Gros Ventre Range, 225; Teton Range, 30; Hoback watershed area, 50; Absaroka Range, 400.

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A SEVENTY-YEAR HISTORY OF A COLORADO BEAVER COLONY

BY DON J. NEFF

Reliable chronological records of the development of individual colony sites over a period of years are rare in the voluminous literature on the beaver, *Castor canadensis*. A picture of ninety years of beaver history based on L. H. Morgan's pioneer studies in the Upper Peninsula of Michigan is provided by Manville (1949). In the Rocky Mountain region an outstanding example is the Moraine Colony, on the Roaring Fork moraine near Long's Peak, Colorado. This colony was first discovered and studied by Mills (1913) over a period of 27 years from about 1885 to 1912. The area was included in an extensive survey of the beaver colonies of the Estes Park region conducted in 1922 by Warren (1926). From photographs taken by Warren at that time it is possible to identify positively the major ponds of the colony. From January to June, 1955, an investigation was conducted by the writer under the auspices of the Colorado Cooperative Wildlife Research Unit for the purpose of bringing the recorded history of the colony up to date and obtaining from it all possible information relating to the development of the colony site.

Assistance and advice of the following persons is gratefully acknowledged: Lee E. Yeager, Leader, Colorado Cooperative Wildlife Research Unit; Ralph R. Hill, Region 2, U.S. Forest Service; John E. Retzer and J. H. Buell, Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service; James E. Cole, Rocky Mountain National Park, U.S. National Park Service; and R. T. King, New York State College of Forestry, Syracuse.

Early history.—The early history of the Moraine Colony is somewhat obscure. The work of Mills was primarily intended for popularizing the wilderness and not for scientific study, and therefore his published observations are often fragmentary and undated.

The earliest mention of the colony by Mills is a rather strange description of a series of three large ponds, the center pond containing no less than eight beaver lodges. This observation was supposedly made in 1885 when Mills was fifteen years old. Mills (1913: 158) then went on to describe a forest fire which swept the area, destroying the colony and forcing the emigration of the beavers. Clements (1910) dated this fire at 1878 from the evidence of post-burn lodgepole pine growth. Burn-scars analyzed during the present study confirmed the date set by Clements.

After the fire Moraine Colony stood empty and undisturbed until the summer of 1893, when beavers reoccupied it. By this time "The willow growth about the ruins was almost as thrifty as when the fire came. A growth of aspen taller than one's head clung to the old shore-lines, while a close seedling growth of lodgepole pine throve in the ashes of the old forest" (Mills, 1913: 164). All the dams had been breached and the ponds drained. The stream had eroded deeply into the old pond fill.

During the first summer of the new colony (1893), the beavers repaired the dams but built no lodges and did not stay for the winter. The following spring the beavers returned and continued the reconstruction, building two new lodges. During that winter (1894–95) both lodges were destroyed, one by a trapper and the other by a bear. Both were rebuilt the following summer.

By 1906 Moraine Colony had dwindled to one pond containing one lodge. But even this small colony was nearing the end of its food supply. The beavers then began building a dam across a boulder-strewn flat in order to provide access by water to a grove of aspens on a slope about 130 feet south and east of Moraine Pond. This remarkable dam was constructed almost entirely of fire-killed spruce logs left lying about after the fire. The finished dam was 85 feet long, averaged 3 feet in height, and had the appearance of ". . . a crude windrow of dead-timber wreckage" (Mills, 1913: 145).

The new "Deadwood Dam" was flooded by a canal which the beavers dug from the creek just below Moraine Dam. A first attempt at digging the canal failed and the "Bow Dam" was built a few feet below Moraine Dam in order to provide a head of water for a second attempt which was successful. The construction of dam and canal took two summers to complete, yet the aspens made available by them were harvested and used in one fall and winter (1907).

In 1908 the big lodge in Moraine Pond was substantially enlarged. By 1912 the colony was abandoned completely (Mills, 1913: 150).

Moraine Colony in 1922.—The destructive erosion which followed the forest fire apparently did not recur after the abandonment of the site. In 1922 Warren (1926) found the colony once more occupied and the dams in substantially the same positions described by Mills 10 years previously.

In 1922 the post-burn forest consisted largely of lodgepole pines of various sizes. Aspens were present in small groves and scattered among the lodgepoles.

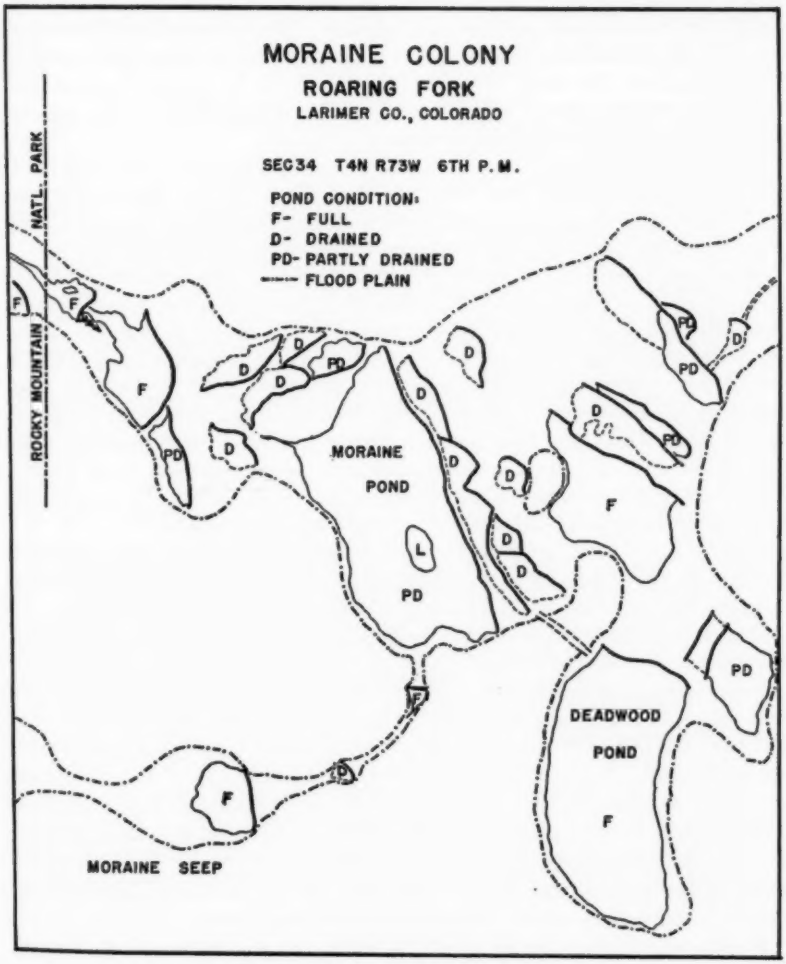

FIG. 1.—Sketch map of the study area.

Large aspens were rare, the majority being less than 4 inches in diameter. The stream was lined with willow, which often grew dense and tall. Alders were common and often of good size. Grass was luxuriant about the ponds. Mills told Warren that the Moraine Pond lodge once measured 84 feet in circumference and Warren said that in 1922 it looked even larger. In 1955 the remains of this lodge measured 85 feet in circumference at the waterline.

Above Moraine Pond Warren found a series of ponds, the first two being of good size and each containing a lodge. About 75 feet upstream was found a pond which was formed when a lodgepole pine on the south bank of the channel fell with the crown pointing downstream. The beavers used the mass of earth in the roots of the tree as part of a dam which created a pond some 15 feet wide and 4 feet deep. The boundary of Rocky Mountain National Park crosses the stream immediately above the fallen pine and marks the approximate upper end of the Moraine Colony.

Aerial photographs of the colony area taken by the U.S. Forest Service in 1938 show little change from the conditions described by Warren 16 years earlier. All the major ponds of the colony were full of water and apparently in good repair.

Moraine Colony in 1955.—The layout of Moraine Colony as it was in the spring of 1955 is shown in Fig. 1. Little change has occurred since Warren's survey 32 years ago. This in itself is an indication of the stability of beaver works on alpine moraines. In fact, a photograph of Moraine Pond taken in 1954 is nearly identical with one taken by Warren in 1922, except that the surrounding forest has grown much taller (Plate I). Most of the smaller ponds in this colony area are at least partially drained. Moraine Pond drained during the winter (1954–55), leaving several inches of ice resting on the pond bottom, but it refilled in the spring. Deadwood Pond and the smaller pond a few yards to the north both held several feet of water through the winter.

Local summer residents reported that several beavers have been present in the colony each summer, but no sign of a wintering population was found during the winter of 1954–55.

Coniferous forest, predominantly lodgepole pine, closely enfolds the colony. There are no longer any aspens around the colony except on Moraine Seep to the southwest of Moraine Pond. The willow seems to be less vigorous than that shown in Warren's photographs. The present willow stand is only 2 or 3 feet tall. The only alders near the colony are found in a small grove about 100 yards upstream. A dense growth of grasses and sedges covers the old beaver structures and the meadow. The ponds, with the exception of Deadwood Dam pond, are filling with sediment washed down by the stream. The Moraine Pond has a maximum depth of about 18 inches at the present time. However, considering that this dam was built in 1893, the rate of sedimentation seems to be very slow. None of the old dams in this colony has been breached.

Beaver scar dating.—In an effort to bridge the gap between the Warren investigation and the present time a series of beaver-scar age determinations

was undertaken. Virtually every lodgepole pine within 15 feet of a pond or watercourse in Moraine Colony has been scarred by beavers. A total of 226 of these scars were cut open with a knife or increment borer and the date of the scar determined by counting the subsequent annual growth rings.

The results of the scar-dating work are shown in Fig. 2. The method was found to be effective for scars up to about 35 years old. Older scars were usually completely healed and unrecognizable and were found only by accident. At least a few scars were made each year since 1919, indicating that a few beavers were present every summer. Four peaks of activity are indicated by the data: 1922 to 1925; 1928 to 1931; 1937 to 1944; and 1948 to 1949. These peak periods agree in at least two instances with other information: in 1922

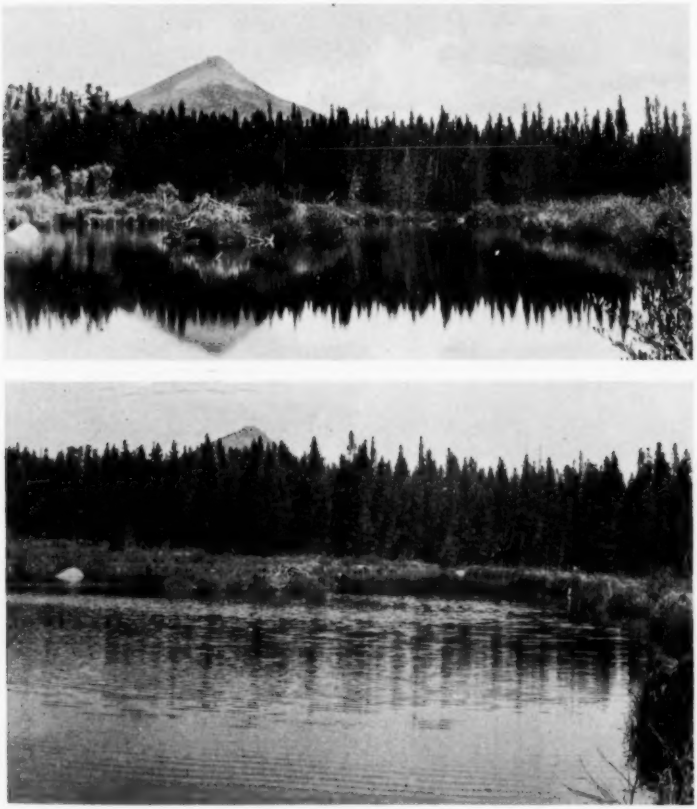

PLATE I

Pair of matching photographs of Moraine Pond taken from the south end of the dam, facing northwest. ABOVE: by Warren, 1922. BELOW: by Retzer, 1954.

Warren found fresh beaver sign to be plentiful, and in 1938 the U.S. Forest Service aerial photographs showed all ponds full and apparently occupied. However, it is impossible to determine from the evidence at hand how long the present system of summer occupation and winter abandonment has been followed. Thus, it is not known when Moraine Colony was last used as a year-round residence by beavers. Since none of the numerous colony sites on the Roaring Fork moraine above Moraine Colony was occupied by beavers during the winter of 1954–55, it must be supposed that the summer visitors to the area came from colonies downstream.

Two factors are apparently involved in maintaining the dams of Moraine Colony in good condition: (1) the inherent physical stability of beaver colony sites on glacial moraines is clearly demonstrated; and (2) the regular summer visitors have attended to minor repairs as needed.

Moraine Colony also may be considered an example of the insecurity of beaver populations in the Rockies which have depleted their supply of aspen and are forced to subsist on a limited willow stand. Despite the physical stability of the site and the frequent visits of beavers in the summer the Moraine Colony has lost its status as a year-round residence for beavers.

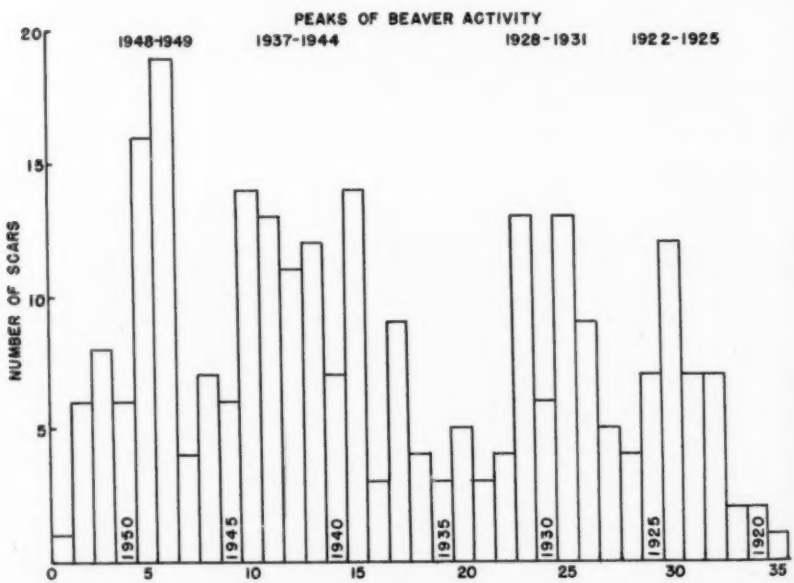

FIG. 2.—Peaks of beaver activity determined by dating beaver scars on lodgepole pines near the colony.

SUMMARY

From January to June, 1955, field investigations were conducted in the vicinity of Moraine Colony, Roaring Fork, near Long's Peak, Colorado. A 70-year history of this beaver colony was pieced together from the reports of Mills (1913) and Warren (1926), from aerial photographs taken in 1938, and from analysis of beaver scars on trees in the colony area.

The history of the colony shows at least two periods of abandonment alternating with periods of reoccupation. Beaver scars on trees indicate constant occupation for the past 30 years, with four prominent peaks of activity.

The ponds which make up the colony have suffered no major erosion or other damage for periods up to 60 years.

The colony is now deserted in the winter time and is reoccupied by beavers each summer. The colony has lost its status as a permanent habitation for beavers, probably because of a shortage of aspen and willow for winter food.

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609 Douglas Ave., Prescott, Arizona. Received January 23, 1958.

VARIATION IN THE OS PENIS OF TROPICAL FRUIT BATS

By Philip H. Krutzsch

Published reports regarding the structure of the os penis (baculum) in the Megachiroptera (Pteropidae) are few. Davis (1947) has described and illustrated the bone of five of the species of the genus *Pteropus* and Chaine (1926) has a drawing of the baculum of *Rousettus edulis*. The present account provides data obtained from a collection of bacula representing 10 genera and 16 species and subspecies of pteropids. It is hoped that a comparative study of the bacula will provide evidence useful for a more accurate and natural grouping of the family at the generic and suprageneric levels. All bacula studied were dissected from the dried fleshy penis cut from museum study specimens. A general orientation for descriptive facilitation in respect to the proximal, distal, dorsal and ventral aspects of the bone was made, and the relationship of the urethra to the bony baculum was determined.

In order to facilitate the study and the handling of the specimens the bones were dissected, stained and mounted according to the method developed by White (1951). This report is only possible because of the kindness of Messrs. Hobart M. Van Deusen and Richard Archbold, who made available for study the specimens in the Archbold Collections of the American Museum of Natural History.

All of the species described are known to me by a small sample; therefore, the range of variation between individuals and variation due to age have not been ascertained.

Differences between the bacula within a single genus are chiefly in minor details of shape, outline and gross size. Genera, however, may be separated from one another by more profound differences in size and in morphological character (e.g., round as compared to elongate, or arrow-shaped as compared to horseshoe-shaped) of the baculum.

The significance of the os penis as an aid in defining relationships and natural groupings among various orders possessing this element has been amply documented. Hamilton (1949) and Krutzsch and Vaughn (1955) have indicated the significance of this element as an aid in defining specific and supraspecific relationships in bats. These authors are of the opinion that the baculum can serve as additional evidence or, in the absence of other clear-cut distinguishing characteristics, as a criterion for judging relationships. As Davis (1947) remarks, in his report on the bacula of five species of *Pteropus*, more adequate material (examples from other species of the genus) would undoubtedly result in considerable revision of the supraspecific groupings. It has been suggested by White (1953) that the structures of the bacula in chipmunks are probably less affected by the action of the external environment and might, therefore, indicate relationships more clearly than do characteristics of the skin and skull which are more directly under the influence of the environment. Tate (1942), in his excellent report on the Pteropidae, pointed out the fact that the criteria for determining natural affinities of the Megachiroptera are complex and contradictory. He further demonstrated that some taxonomic relationships in this group are based upon disappearing structures: the claw of the second finger (*d*2) of the wing, certain teeth and the tail. Other characters that are used represent adaptive structures not necessarily leading to obsolescence of organs: the degree of bending of the skull whereby the facial axis may form an angle with the basicranial axis; the two distinct types of premaxillae accompanying long or short nasals and the correspondingly modified anterior portion of the palate. Adaptations of jaws and teeth are additional examples. The baculum with its relative simplicity and stability of structure might well serve to help place entities of doubtful relationship, which are otherwise contradictory morphologically, as to their natural position.

From studies based upon several suites of species in a single genus we find that, although well marked and consistent differences in the baculum of each species exist, there usually is a basic similarity in pattern throughout the genus

(Fig. 1: I, J and K). This similarity of basic pattern was also demonstrated by Davis (1947) for species in the genus *Pteropus*. Instances of marked variation in the morphological characteristic of the os penis between species in a single genus might be considered grounds for reappraisal of the variant's affinities.

The following descriptions of the bacula of the species studied are intended to supplement the drawings presented (Fig. 1). The bats are grouped according to the arrangement presented by Tate (1942).

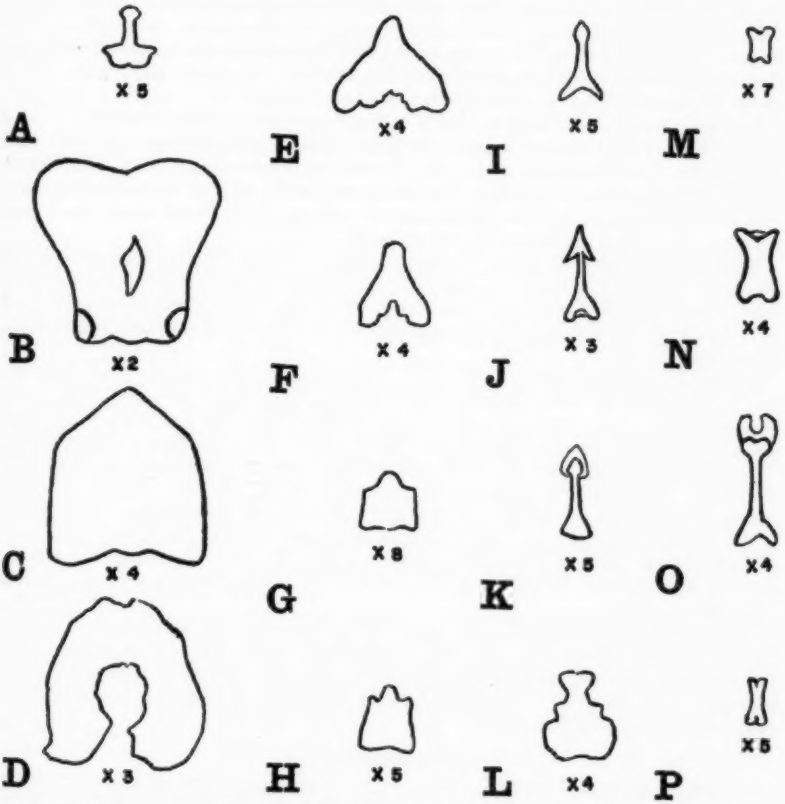

FIG. 1.—Representative figures of the bacula of the bats: A, *Rousettus amplexicaudatus brachyotis*; B, *Pteropus neohibernicus papuanus*; C, *Pteropus macrotis eqularius*; D, *Aceroden celebensis*; E, *Dobsonia moluccensis magna*; F, *Dobsonia moluccensis pannietensis*; G, *Cynopteris brachyotis angulatus*; H, *Cynopteris h. horsfieldi*; I, *Nyctimene albiventer papuanus*; J, *Nyctimene aello celaeno*; K, *Nyctimene major geminus*; L, *Eonycteris spelaea glandifera*; M, *Macroglossus l. lagochilus*; N, *Macroglossus lagochilus nanus*; O, *Saconycteris crassa papuana*; P, *Saconycteris* sp. All figures are of the ventral aspect; approximate magnification is indicated for each.

Subfamily Pteropidinae

Rousettus Section

Rousettus amplexicaudatus brachyotis (Fig. 1:A).—This species is represented by a single specimen (157330 AMNH) taken from the Tapitapipi Caves, Dabera, Cape Vogel Peninsula, Papua, New Guinea. In dorsal view the baculum is mushroom-shaped with the base wide and round. The distal end of the penis flairs slightly and is wider than the shaft. The ventral surface of the bone is concave and roofs the urethra. The entire structure is 2.8 mm. long.

Pteropus neohibernicus papuanus (Fig. 1:B).—A single specimen (157325 AMNH) taken at Bottom Camp, elevation 700 meters, on the north slopes of Mt. Dayman, Maneau Range, Papua, New Guinea was studied. When viewed from the dorsal aspect the baculum is a saddle-shaped structure that is raised at each end and depressed in the middle. Proximally the bone forms an incomplete ring to encircle the urethra which passes through it from below; distally the baculum broadens and is one-third wider than the base. The distal margin turns upward almost like the tip of a ski. The structure is 14.0 mm. in length.

Pteropus macrotis epularius (Fig. 1:C).—A single specimen (159330 AMNH) obtained at Menapi, Cape Vogel Peninsula, Papua, New Guinea was available for study. In dorsal view this structure is saddle-shaped yet the bone is not at all similar to that of *P. neohibernicus*. Distally the shaft narrows abruptly to a rounded point; basally the shaft is broad and truncate. The entire ventral surface of the bone is concave and appears U-shaped when viewed from either end. The single specimen is 8.0 mm. in length.

Aceroden celebensis (Fig. 1:D).—A single specimen (153545 AMNH) obtained at Mengkika Mts., Vawo, SE Celebes was examined. This structure is a horseshoe-shaped plate that is slightly convex dorsally and concave ventrally. The bone caps the distal end of the urethra and is 8.0 mm. long. The spicule is more massive than the spicules known to us from species of the genus *Pteropus*.

Dobsonia moluccensis magna (Fig. 1:E).—This species is represented by two specimens, one (157353 AMNH) from Tapitapipi Caves, Debera, Cape Vogel Peninsula, Papua, New Guinea, and the other (157360 AMNH) from Bottom Camp, 700 meters elevation, north slopes Mt. Dayman, Maneau Range, Papua, New Guinea. These structures are broad basally (there is a notch indenting the base at the midline) but narrow to a very short bluntly rounded tip distally. When viewed ventrally the bone is wedge-shaped, and this surface is concave to permit the passage of the urethra over which the element lies. The specimen from Bottom Camp is shorter (6.0 mm. long) than that from Tapitapipi Caves (7.3 mm. long) and is less ossified, perhaps representing a juvenile animal. Hobart M. Van Deusen suggested that the animal is a young adult, basing his opinion on the sharp, unworn teeth and smaller external dimensions.

Dobsonia moluccensis pannietensis (Fig. 1:F).—We have studied a single specimen (157362 AMNH) obtained at Bolu Bolu, Goodenough Island, Papua, New Guinea. The baculum of this bat is shaped, in general, like the baculum of *D. m. magna*, differing only in its smaller size (3.6 mm. long) and deeper notching in its base. The bone, as is true of *D. m. magna*, cups the urethra from above.

Cynopterus Section

Cynopterus brachyotis angulatus (Fig. 1:G).—Two specimens (102608 and 122617 AMNH) obtained from Macarah Doewa, Sumatra were examined. The baculum of this bat is a triangular-shaped structure that is located in the glans just dorsal to the urethra. The bone is small; both specimens measured 1.8 mm. in length.

Cynopterus h. horsfieldi (Fig. 1:H).—Two specimens (102382 and 102385 AMNH) obtained at Tjerimai, elevation 1,700 meters, Java were studied. The baculum of this species is also a wedge-shaped bone, convex dorsally and concave ventrally. The structure is located in the glans and overlies the distal end of the urethra. The bone is similar to that of *C. brachyotis* but more than four times larger, measuring 9.0 mm. in length.

Nyctimene albiventer papuanus (Fig. 1:I).—This species is represented by a single specimen (105119 AMNH) obtained from 5 miles below Palmer River Junction, Fly River, Papua, New Guinea. The baculum of this species is arrow-shaped, the tip only slightly barbed. The bone is grooved ventrally to allow the passage of the urethra which it caps. The element measured 3.8 mm. in length. All species known to us in this genus have similar basic morphological structure and differ from one another chiefly in the degree of barbing at the tip.

Nyctimene aello celaeno (Fig. 1:J).—Two specimens (105138 and 105143 AMNH) from 5 miles below Palmer River Junction, Fly River, Papua, New Guinea were available for study. The os penis of this bat is arrow-shaped with a broad base, a short narrow shaft and a barbed tip. The structure overlies the urethra in the glans and is grooved lengthwise on the ventral surface, presumably to allow passage of the urethra. Both specimens measured 4.0 mm. in length.

Nyctimene major geminus (Fig. 1:K).—A single specimen (157387 AMNH) was studied. This animal was obtained from Goodenough Island, Papua, New Guinea. The baculum is arrow-shaped, the form typical of the genus. This species differs but slightly from the others studied. The structure is not quite so broad basally nor so barbed distally, and the shaft is more elongated and slender than in other known species of this genus. The bone is 3.8 mm. in length and lacks a pronounced ventral groove.

Subfamily Macroglossinae

Eonycteris spelaea glandifers (Fig. 1:L).—Two specimens (107904 and 107908 AMNH) from Soka, Bali differ somewhat from one another; however, the basic pattern is similar and the bones were also located in the glans dorsal to the urethra. The ventral surface of each is concave, presumably to allow passage of the urethra. The two elements differ chiefly in the extent of winging lateral to the shaft; these differences may be subspecific or due to age. Both bones measured 4.0 mm. in length. Tate (1942: 345) was doubtful of the taxonomic position of these specimens and uncertain whether to refer them to *E. s. bernsteini* or *E. s. glandifera*; perhaps both subspecies are here represented.

Macroglossus l. lagochilus (Fig. 1:M).—A single young adult (109094 AMNH) from Peleng Island, Celebes was examined. The baculum of this bat is small, rectangular and notched at each end. There is a groove ventrally, presumably to allow the passage of the urethra. The urethra is capped in the distal glans by the baculum. The bone measured 1.0 mm. in length.

Macroglossus lagochilus nanus (Fig. 1:N).—We have a single specimen (154741 AMNH) obtained at Seggrens Farm, 10 miles west of Cooktown, Queensland, Australia. This baculum is morphologically similar to, but four times larger than, the baculum of *M. l. lagochilus*. The bone measured 4.0 mm. in length.

Saconycteris crassa papuana (Fig. 1:O).—This species is represented by a single specimen (157374 AMNH) from Menapi, elevation 23 meters, Cape Vogel Peninsula, Papua, New Guinea. The baculum is widened basally by wing-like projections. Distally the shaft divides into two rounded facets which support cartilaginous horn-like processes. Ventrally the bone is concave and caps the urethra in the glans. The bone, with cartilage processes, measured 6.0 mm. in length.

Saconycteris sp. (Fig. 1:P).—The baculum of a single specimen (157379 AMNH) from Top Camp, elevation 2,230 meters, north slopes Mt. Dayman, Maneau Range, Papua, New Guinea differs from the bacula of *S. c. papuana*. The element is much smaller (2.0 mm. compared to 6.0 mm.), although the general shape of the structure is typical of the genus. In addition the bone differs by lacking the cartilaginous processes on the bifurcated and rounded distal ends of the shaft.

Too few representatives of the large number of widely divergent genera of the Megachiroptera have yet been studied to allow one to generalize regarding an arrangement utilizing the structure of the os baculum as a criterion for determining affinity. It has, nevertheless, become apparent that this element may have a high degree of stability of form in a series of species

representing a single genus. It has been further noted that there may be basic similarities in the form of the baculum between representatives of different genera and, contrariwise, strong dissimilarity in form between representatives of other genera. These characteristics have been taken to indicate probable degree of relationship between the groups considered.

We are cognizant of the fact that the os penis is but one of several criteria for evaluating relationships and that our repertory of species examined is limited. However, hope is held that, when a respectable segment of the known species has been studied, the baculum will be found to be of real significance in understanding the relationships of the Megachiroptera.

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USE OF THE CALCANEUM IN STUDIES OF TAXONOMY AND FOOD HABITS

BY HOWARD J. STAINS

In an analysis of mammalian material in scats of raccoons, *Procyon lotor*, bones of the feet of small mammals occurred more frequently than other skeletal remains. A study of foot bones from identified skeletal materials was made to determine the feasibility of using such bones for the identification of the mammals eaten. The calcaneum was found to be distinctive, even in species. Therefore, it is believed that this bone can be useful in taxonomic as well as food habits investigations.

The calcaneum, which forms the heel, is the largest bone of the foot. In general, this bone is at least twice as long as broad. Calcaneal terminology differs among authors. The terms proximal and distal have been misused in many cases. To be accurate the terms proximal and distal should apply only to that part of the calcaneum resting in the tarsal complex. The body and calcaneal tuberosity should be regarded as a process. The calcaneal tuberosity has a groove for the tendon of Achilles. At the distal end of the calcaneum there is a

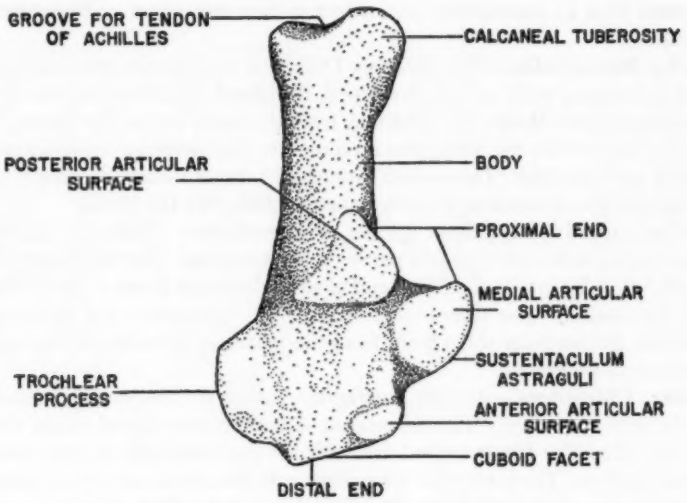

FIG. 1.—Dorsal view of a generalized calcaneum.

facet for junction with the cuboid. On the dorsal surface, articulation at two or three points (sometimes more) is made with the astragulus or talus (Fig. 1). Several characteristics of the calcaneum vary significantly: the total length or size of the bone; the position, or even the presence, of a trochlear process (peroneal turbercle); the number of articular surfaces; and the bones with which it articulates.

METHODS

The calcaneum of the right foot was disarticulated from the skeleton of identified material. The bone was examined and drawn to scale under a binocular microscope into which an ocular micrometer had been inserted. Calcanea too large for microscopic illustration were measured with dial calipers and drawn to scale. The greatest difficulty was orienting the bones in the same perspective. Satisfactory results were obtained only after considerable experience with many different kinds of calcanea.

I wish to thank Professor E. Raymond Hall of the Museum of Natural History, University of Kansas, for the loan of many of the comparative materials. This is a contribution from Project No. 11, Cooperative Wildlife Research Laboratory, Southern Illinois University.

ORDINAL VARIATION

All members of an order may not be identical to the representative illustrated (Fig. 2) as only a few specimens were examined. Little obvious deviation from

a general plan of construction is evident within any given order except the Rodentia.

Order Marsupialia.—The opossum, *Didelphis marsupialis*, possesses a short broad calcaneum with a well-developed, V-shaped trochlear process located approximately one-third of the distance from the distal end of the bone. Three articular surfaces for the astragulus are present. The posterior articular surface is round and knoblike. The cuboid articulates with a V-shaped surface at the distal end of the calcaneum; there is no articulation with the fibula.

Order Insectivora.—Three species of insectivores (*Scalopus aquaticus, Blarina brevicauda* and *Cryptotis parva*) were examined. The trochlear process is located distally so that the distal end of the calcaneum forms a sharp slope to the sustentaculum. The anterior articular surface is absent in the three genera examined. An irregular ridge leads from the posterior articular surface toward the calcaneal tuberosity.

Order Chiroptera.—*Myotis lucifugus, Eptesicus fuscus* and *Lasiurus borealis* were examined. The calcaneum is boomerang-shaped when viewed from the side. The fibula articulates with the proximal side of the posterior articular surface. The astragulus articulates with the distal side of the posterior articular surface and with the medial articular surface. The cuboid articulates at the distal end of the calcaneum. The body and calcaneal tuberosity extend

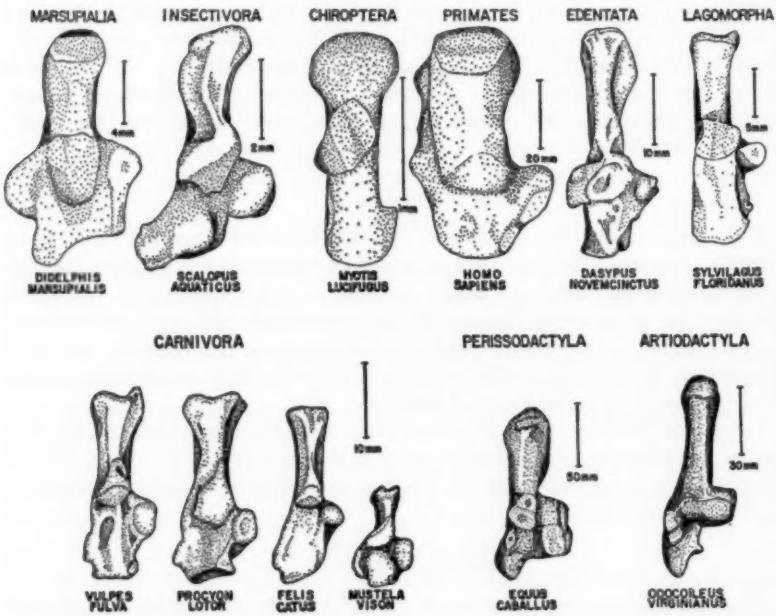

FIG. 2.—Calcanea of representatives of orders of North American mammals. Dorsal views.

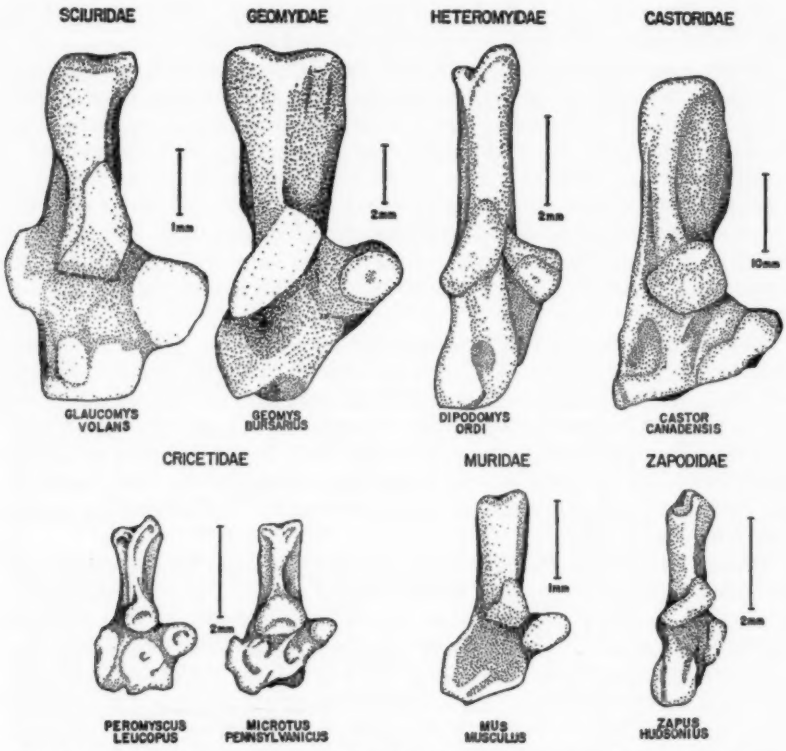

FIG. 3.—Calcanea of representatives of families of North American rodents. Dorsal views.

outward at a 45° angle from the articular region of this bone. From the tuberosity extends the calcar, a cartilaginous rod which helps support the interfemoral part of the flight membrane. The specimens examined indicate that there may be considerable variation in size and shape of this bone, at least between bats belonging to different genera. Allen (1886) examined the tarsi of six genera of bats and noted some differences in size and articulations of the calcaneum.

Order Primates.—The calcaneum of *Homo sapiens* has three points at which the astragulus articulates and is a short, broad, massive bone. The trochlear process is reduced to a small projection. The articulations, as described for the rhesus monkey by Hartman and Straus (1933: 81) and for the gorilla and Neanderthal man by Morton (1935: 62), are similar. *Tarsius* is well known for the extreme elongation of the calcaneum (Kingsley, 1925: 301).

Order Edentata.—The armadillo, *Dasypus novemcincus*, has, at the outer end of the posterior articular surface, an additional articular surface over which the fibula moves. The trochlear process is absent as is the anterior articular

surface. The distal end of the bone is triangular in shape. When viewed from the ventral surface, the body is extremely long and narrow.

Order Lagomorpha.—The cottontail, *Sylvilagus floridanus*, and the jack rabbit, *Lepus californicus*, possess greatly elongated calcanea having three articular surfaces for the astragulus. The anterior articular surface is small and located on the inner side of the calcaneum. The posterior articular surface is spool-shaped and expanded to form an additional articular surface for the fibular side of the tibiofibula. The distal extremity of the bone articulates with the scaphoid (navicular) as well as with the cuboid. There is no evidence of a trochlear process. The description of the calcaneum of the European rabbit, *Oryctolagus cuniculus*, given by Bensley (1946: 201) is similar to that of the two species above.

Order Rodentia.—The rodents vary considerably in the type of calcaneum possessed by members of different families (Fig. 3). The calcanea of all rodents examined have a distinct trochlear process and articular facets for the astragulus and cuboid. There are two basic types of calcanea in rodents. One type resembles the calcaneum of carnivores more closely than that of any other order; the other, possessed by those rodents which hop, resembles the bone found in insectivores more closely than that of any other order. The rodents are considered later in more detail.

Order Carnivora.—The carnivores examined (*Procyon lotor, Canis familiaris, Urocyon cinereoargenteus, Vulpes fulva, Felis catus* and *Mustela vison*) have calcanea with a small trochlear process located distally. Three articular surfaces are present in all specimens examined except *Felis*, which lacks the anterior articular surface. Members of the Procyonidae, Canidae and Felidae possess calcanea which are similar in form; the mink (Mustelidae) has a shorter calcaneum in relation to width. Of the genera within the Canidae, the calcanea are similar except for minor structural differences and size.

Order Perissodactyla.—The horse, *Equus caballus*, has a short, massive calcaneum which, together with the usual three articular surfaces (posterior, medial and anterior), contains two additional surfaces for the astragulus on what may be a greatly modified trochlear process. The sustentaculum, on which the anterior and medial articular surfaces are broadly connected, is greatly thickened, thus forming a massive projection. Two facets are present on the distal end of the bone; one for articulation with the cuboid and a smaller one for articulation with the scaphoid (navicular).

Order Artiodactyla.—The cow, *Bos taurus*, and the white-tailed deer, *Odocoileus virginianus*, have calcanea on which the posterior articular surface is deep and almost at right angles to the longitudinal axis of the bone. The medial articular surface seems to be a continuation of the posterior articular surface and is at the same angle. The anterior articular surface is a narrow dish-shaped surface nearly parallel with the longitudinal axis of the bone. The trochlear (peroneal) process is rounded above (proximal) and, forming a notch distally, articulates with the lateral malleolus (fibula). The inner surface of the trochlear

process has an astragular articulation which is a continuation of the posterior articular surface. The cuboid side of the fused scaphocuboid bone articulates on the distal inner surface of the calcaneum and is at a sharp angle so that the distal end of the calcaneum comes to a point and presents a V-shaped appearance.

VARIATION AMONG FAMILIES OF RODENTS

Examples of several families of rodents were examined. The more noticeable differences are in the size and position of the trochlear process (Fig. 3).

Family Sciuridae.—The calcanea of squirrels have two articular surfaces. The proximal end of the trochlear process, both in terrestrial squirrels (*Marmota monax* and *Tamias striatus*) and in tree-living squirrels (*Glaucomys volans* and *Sciurus niger*), is even with or slightly proximal to the distal edge of the posterior articular surface. The distal end of the trochlear process is more proximal than that of any other calcaneum examined, although those of the opossum (*Didelphis*) and the wood rat (*Neotoma*) approach this condition.

Family Geomyidae.—Two genera of gophers (*Geomys* and *Thomomys*) were examined. The calcanea show greater similarity to those of the microtines than of other rodents. There are two articular surfaces for the astragulus. The posterior articular surface is expanded and tends toward being nearer parallel to the longitudinal axis of the bone than in many mammals. The trochlear process is located distally and reduced in size. There is a deep pit at the distal end of the posterior articular surface in *Geomys*.

Family Heteromyidae.—The kangaroo rat, *Dipodomys ordi*, silky pocket mouse, *Perognathus flavus*, and hispid pocket mouse, *Perognathus hispidus*, have calcanea which are long and narrow. The trochlear process is distal and the slope to the sustentaculum is steep.

Family Castoridae.—The beaver, *Castor canadensis*, has a massive calcaneum wtih a greatly reduced trochlear process located distally. The slope from this process to the sustentaculum is gentle. The medial and anterior articular surfaces are continuous except for a slight constriction. The calcaneal tuberosity is expanded dorsoventrally.

Family Cricetidae.—The calcaneum of the cricetids contains two or three articular surfaces for the astragulus. There is a well-developed trochlear process which is located more distally in the Microtinae than in the Cricetinae. Variation within this family is considered in more detail later.

Family Muridae.—The calcaneum of the house mouse, *Mus musculus*, has the posterior and medial articular surfaces. The trochlear process is greatly expanded.

Family Zapodidae.—The jumping mouse, *Zapus hudsonius*, has a distal trochlear process with the usual slope to the sustentaculum. The posterior articular surface is elongate laterally as in other jumping animals and is elevated by the bony process which supports this surface. The entire surface of the articular end of the calcaneum is elevated well above the body and calcaneal tuberosity of the bone. The anterior articular surface is absent.

VARIATION WITHIN THE FAMILY CRICETIDAE

The family Cricetidae was studied in some detail. The calcanea in the subfamilies Cricetinae and Microtinae differ in the position of the trochlear process. In the Cricetinae, the trochlear process is more proximal than in the Microtinae so that the lower end of this process is located above (proximal to) the articular surface of the cuboid. The lower or distal ends of the calcanea in the Cricetinae thus are broad U-shaped structures.

Six genera of the subfamily Cricetinae have calcanea of similar shape but differ considerably in size. Of these six, *Neotoma, Sigmodon, Onychomys* and *Reithrodontomys* have the three articular surfaces, but *Oryzomys* and *Peromyscus* lack the anterior articular surface. The most obvious difference is that of size (Fig. 4). An examination of only a few specimens in each of these genera shows that there is little overlap in the greatest length and width (Table 1). Undoubtedly, there is more overlap in size of the calcanea between genera than found in this small sample because the calcanea of species within the genera often vary considerably in size. Examination of *Peromyscus leucopus* and *Peromyscus maniculatus* reveals that within these two species there is no overlap in size and that size, in fact, is rather constant within the species, at least in local populations. *Peromyscus leucopus* was found to vary from 3.56 to 4.22 mm. (avg. of 26 specimens, 3.88 mm.) in length of the calcaneum (measured with an ocular micrometer) and from 2.11 to 2.51 mm. (avg. 2.30 mm.) in width. The calcaneum in *Peromyscus maniculatus* varied from 3.04 to 3.30 mm. (avg. of 6 specimens, 3.21 mm.) long and from 1.85 to 2.05 mm. (avg. 1.95 mm.) wide.

FIG. 4.—Calcanea of some North American Cricetinae. Dorsal views.

TABLE 1.—*The comparative size of calcanea of some genera of the subfamily Cricetinae*

GENUS	NO. OF SPECIES EXAMINED	NO. OF SPECIMENS EXAMINED	RANGE, GREATEST LENGTH, mm.	RANGE, GREATEST WIDTH, mm.
Reithrodontomys	1	6	2.77–3.04	1.45–1.72
Peromyscus	3	34	3.04–4.22	1.85–2.51
Onychomys	1	6	4.29–4.75	2.51–2.77
Oryzomys	2	4	4.88–5.41	2.77–3.17
Sigmodon	1	6	6.47–7.00	3.70–4.09
Neotoma	1	2	8.98–9.64	5.28–5.94

In the Microtinae, the lower end of the trochlear process is located distal to the articular surface for the cuboid. The lower end of the microtine calcaneum is more or less evenly sloped from the trochlear process to the sustentaculum upon which is located the medial articular surface for the astragulus. The calcaneum in the microtines seems to vary more both within and between genera than it does in the cricetines. Although size is sometimes useful, at least three additional variations are noticeable: the position of the trochlear process, a peculiar enlargement and twisting of the body (Fig. 5), and the presence of a third articular surface (the anterior) for the astragulus.

The genera *Phenacomys, Lemmus* and *Dicrostonyx* have the most obvious enlargement and twisting of the body of this bone. The genera *Phenacomys, Dicrostonyx* and *Lagurus* have the most obvious anterior articular surfaces. The calcaneum of *Ondatra* has a poorly developed anterior articular surface and in

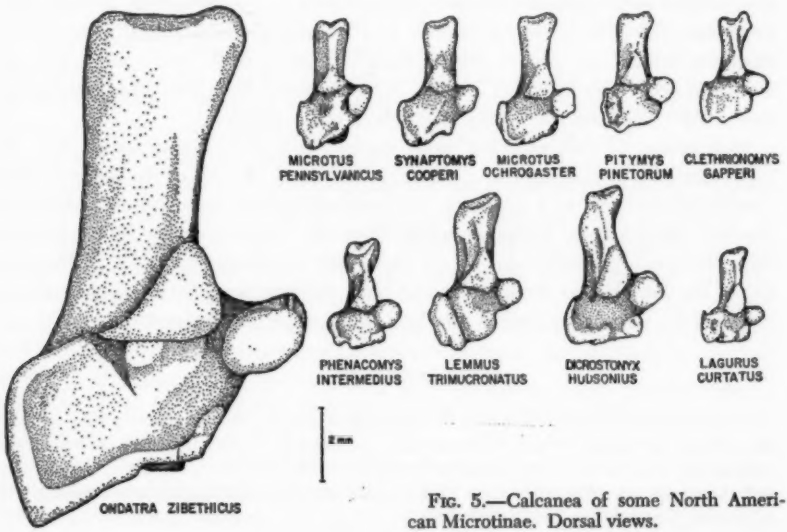

FIG. 5.—Calcanea of some North American Microtinae. Dorsal views.

addition has a slight continuation of the posterior articular surface onto the broad distal region. Figure 5 indicates the comparative size of the ten genera examined.

DISCUSSION

Functionally, the calcaneum is one of the most important osteological features of the leg (Howell, 1926: 170). This bone acts as a lever, moved by the crural extensor muscles of the leg. A survey of the literature indicates little investigation of the comparative aspect of the calcaneum, at least in North American mammals. Most work is of a descriptive nature on a given species, particularly among primates. Forster (1928: 320) studied the calcanea of a series of 14 genera and concluded that there had been a progressive evolution of the calcaneum which tended to exclude this bone more and more from the role of supporting body weight. There also seemed to be some kind of compensatory equilibrium between the bony parts; for example, when the body (and calcaneal tuberosity) of the calcaneum is elongate, the sustentaculum is smaller. These changes seemed to be best explained by changes in the transmission of body weight (Forster, 1928: 324–325).

The calcaneum is of extreme interest not only because of the important functional role that the bone plays but also because the calcaneum seemingly retains basic characteristics at various taxonomic levels. One example of this retention is found in the squirrels. Four different genera of squirrels were examined; the groundhog, chipmunk, fox squirrel and flying squirrel. Functionally, these four squirrels live in four rather different habitats and would, perhaps, be expected to possess four rather specialized and different heel bones. However, though there are minor differences, the similarity of the four is striking. All four possess calcanea of like form having two articular surfaces, a well-developed sustenaculum, and a trochlear process located more proximal than any other calcaneum examined (*Neotoma* resembles squirrels in some respects).

This seems to indicate that even though function undoubtedly plays an important role in shaping the calcaneum, the basic pattern of the bone is fixed genetically and retains a similar shape in closely related individuals of different genera. Since a basic pattern remains through other taxonomic levels as well, the calcaneum probably can be an important taxonomic tool. In addition, it might be valuable in studies dealing with mammalian identification such as required for food habit studies and by archeologists and paleontologists.

SUMMARY

A cursory examination of calcanea of mammals of various taxonomic categories revealed the presence of similarities and differences in the calcaneum both within and between these various taxonomic levels. The calcaneum seems to possess characteristics useful in taxonomy and should be investigated further. For identification in food habits investigations, the calcaneum is a useful tool in limited areas.

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VERTEBRATE REMAINS FROM A MISSOURI CAVE

BY PAUL W. PARMALEE AND KARL W. JACOBSON

Published data dealing with animal remains from natural caves and rockshelters throughout much of the Midwest have pertained to fossil fauna or been limited largely to information from archaeological investigations. With reference to Missouri, Fowke (1922) discussed the early survey work and listed some of the animals identified from bones recovered in midden deposits. These remains found in cave floors, refuse pits and the general kitchen midden debris associated with prehistoric Indian sites provide a wealth of information concerning the early ecology of an area and its faunal composition.

Some of the larger and better-known caves have been studied for many years (Nicholas, 1954) and, where conditions are favorable to the preservation of bone, much has been learned of the former distribution and abundance of animals in extremely early periods. During recent years speleologists and investigators on bats and other cave-dwelling species have encountered valuable bone deposits. In 1950 and 1953, Donald M. Johnson found remains of peccary, among others, in Jacob's Cave, Morgan County, Missouri. Similar finds were recovered from a former underground river channel in St. Louis (Simpson, 1946). A large sample of bone recently removed from a cave (vertical shaft) near Columbia by William H. Elder contained quantities of black bear and other bones.

The basis for this report is the bone remains recovered from a vertical fissure, referred to locally as Jerry Long Cave, located approximately 4 miles north of Perry, Ralls County, Missouri. A small sample of bone was first removed by the

junior author during preliminary explorations, and in subsequent visits by the authors (Nov. 13, 1956; Jan. 2, March 8 and May 4, 1957) considerably more was unearthed. No fossil animals were represented and it appears that the material is of fairly recent origin, probably most of it accumulating for several hundred years prior to about 1850.

Description of cave and area.—The entrance to Jerry Long Cave (the cave proper being a vertical fissure) is situated on the face of a limestone bluff overlooking Lick Creek and is approximately 80 feet above the creek bed. There is a narrow ledge running along portions of the bluff and back from this ledge at one point is a shallow, horizontal cave, the opening being approximately 5 feet wide and 4 feet high. The cave tapers sharply toward the back and terminates 8 feet from the ledge. The opening to the vertical fissure, about 3 feet long and 1½ feet at its widest point, is located at this terminus.

The vertical fissure gradually increases in diameter from about 5 feet immediately below the opening to roughly 18 feet at the first (and largest) level, a drop of approximately 45 feet. There is an oval-shaped opening in the floor of this first level that leads down into another room approximately 20 feet high, 15 feet long and 8 feet wide. Adjoining this lower room by a very narrow passage is a third chamber, roughly oval in shape (3 × 6 feet) at the base and appearing as a cone-shaped fissure with a very high apex but with no entrance or opening at the top.

All of the animals apparently entered the fissure through the small opening at the rear of the horizontal cave. The fissure appears to have been formed through the leaching action of water and much of the wall surface is coated with dripstone; careful examination failed to reveal other openings to the outside at the lower levels. The bottom is littered with pieces of limestone of varying sizes, mixed with soil and a small quantity of sticks and leaves.

Since the opening into the fissure is relatively small, it is difficult to ascertain why it served as such an effective death trap. Undoubtedly many individuals of the smaller species, such as skunks, rabbits, woodchucks, wood rats and squirrels, accidentally fell through the opening; but such animals as the black bear and bobcat needed to make a special effort to squeeze through the opening. In many instances this was probably the result of normal wandering in search of food, den sites, etc.

Ralls County is centrally located in the Northeastern Riverbreaks region (Bennitt and Nagel, 1937). Originally about 43 per cent of the region was in timber, but now less than half of this is still wooded. The bluff face is covered with stands of sugar maple, white oak, red cedar, American elm, shagbark hickory and black walnut, while sycamore is the dominant species along the creek and in the flood plain. Large tracts of bottomland and slope near the cave are under cultivation and some lumbering is done. This mixture of habitat types is favorable for game species.

Methods.—An attempt was made to remove the material on a one-foot-level basis but, because of the irregular slope of the floor and confined working con-

ditions, it was difficult to maintain uniform units. Depth of deposit varied from about 1 to 3 feet in the lower room and in its small side cavity; bone was removed from these two areas first and then the rock and debris from the main room above were thrown into them after they were examined. Although no rain can enter the main fissure directly, seepage is evident during periods of high rainfall and, at a depth of 2 to 3 feet, the soil-rock mixture is moist and most of the bone at these depths is poorly preserved.

This fissure is apparently still serving as a death trap for small mammals. The carcasses of two woodchucks were encountered on the first visit to the cave and, although the flesh was completely gone, the skeletons were fairly intact and still covered with some hide and fur. In most cases, the bones of different animals were widely scattered and not one skeleton was even partially articulated or in place where the animal died. Possibly some animals survived the fall and helped to scatter the remains of those that preceded them; vultures may have been another cause of this dispersal.

TABLE 1.—*Vertebrate species identified from bone remains in Jerry Long Cave, Ralls County, Missouri*

SPECIES	TOTAL IDENTIFIABLE REMAINS	MINIMUM NO. OF INDIVIDUALS
Eastern wood rat, *Neotoma floridana*	437	58
Woodchuck, *Marmota monax*	388	28
Black bear, *Ursus americanus*	222	12
Cottontail, *Sylvilagus floridanus*	93	10
Fox squirrel, *Sciurus niger*	66	7
Spotted skunk, *Spilogale* sp.	39	8
Striped skunk, *Mephitis mephitis*	37	4
Bobcat, *Lynx rufus*	33	6
Raccoon, *Procyon lotor*	38	4
Virginia opossum, *Didelphis marsupialis*	11	2
Man, *Homo* sp.	9	2
Vole, *Microtus* sp.	9	2
Beaver, *Castor canadensis*	5	1
Big brown bat, *Eptesicus fuscus*	4	2
Eastern mole, *Scalopus aquaticus*	3	2
White-tailed deer, *Odocoileus virginianus*	3	1
Brown bat, *Myotis* sp.	2	1
Gray fox, *Urocyon cinereoargenteus*	2	1
Red fox, *Vulpes fulva*	2	1
Deer mouse, *Peromyscus* sp.	2	2
Mountain lion, *Felis concolor*	2	1
Mink, *Mustela vison*	1	1
Bog lemming, *Synaptomys cooperi*	1	1
Turkey vulture, *Cathartes aura*	291	16
Screech owl, *Otus asio*	2	1
Turkey, *Meleagris gallopavo* ?	1	1
Prairie chicken, *Tympanuchus cupido* ?	1	1

Accounts of species.—Table 1 lists the species identified from bones recovered at Jerry Long Cave. One interesting aspect of the material is the quantity of black bear bones. Bennitt and Nagel (1937) state that "Black bear were numerous in the forests that once covered nearly three-quarters of the state. They were uncommon by 1850, though a few stragglers were to be found for two or three decades longer in northern Missouri, . . ." Besides the 12 individuals recovered, there were an additional 412 ribs, vertebrae and phalanges probably assignable to this species. Bones of both adults and cubs were present. Remains of young bear do not necessarily indicate the use of the fissure as a den site.

Bobcats are still taken in the more remote regions of Missouri each year and the bluff area of the cave apparently served as good habitat for this species. The right P^2 and the upper left canine teeth of the mountain lion were the only remains of this large carnivore. Possibly these large animals were attracted to the cave by the odor of other animals that had been trapped there.

Fox squirrel, opossum, cottontail, woodchuck, skunk and raccoon presently occur within the vicinity of the cave and the remains of these species may be logically explained by the animals accidently falling through the fissure. The bones of white-tailed deer, mink and beaver in the floor debris, however, may represent animals which had been previously eaten by one of the carnivores that was later trapped.

George K. Neumann identified portions of human skull (representing at least two individuals) found in the floor debris as probably those of Indian. Again the questions arise as to how and why they entered the fissure: to retrieve trapped or dead animals? from curiosity? Although the bluffs and surrounding fields yield numerous artifacts (potsherds, projectile points) indicating former Indian sites, none were found within the fissure itself and it apparently has no archaeological connection.

Schwartz and Odum (1957) record the wood rat, *Neotoma floridana illinoensis*, as far north as the southeastern quarter of Missouri. We have found no tangible evidence to indicate that the wood rat still inhabits the river bluffs as far north as Ralls County, but judging from the quantities of *Neotoma* remains found in Jerry Long Cave, it must have been abundant in that region during prehistoric times. Possibly it was an important factor in attracting the carnivores to that area.

The presence of nearly 300 bones of the turkey vulture is one rather unique aspect of this problem. All of the vulture bones appeared to be those of adults. It is reasonable to assume that they were attracted to the cave by the odor or sight of carrion on the floor of the fissure (dimly lighted by indirect sunlight from about 1:00 to 3:00 PM). The vultures might have dropped through the opening to feed and been trapped, being unable to fly straight up between the steep, vertical walls.

SUMMARY

Animal remains accumulated during a relatively recent period were recovered from a cave (vertical fissure) located 4 miles north of Perry, Ralls County, Missouri, that formed a natural

death trap for animals inhabiting the area. Twenty-two kinds of mammals and two of birds were definitely identified from the faunal material. Various possible explanations of how these animals came to be trapped are advanced.

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RED-BACKED VOLE HABITAT STUDIES IN CENTRAL MINNESOTA

BY HARVEY L. GUNDERSON

During a study of small mammal populations at Cedar Creek Forest, Anoka County, Minnesota, an attempt was made to determine some factors affecting the local distribution of the red-backed vole, *Clethrionomys gapperi*. Cedar Creek is a research area originated by the Minnesota Academy of Sciences and is now administered by the University of Minnesota. It straddles the Anoka-Isanti county line 4 miles east of Bethel, Minnesota. The work was done in that part of the forest which is in Anoka County.

Cedar Lake makes this forest distinctive. The lake was probably originally formed by an ice block depression in the Anoka Sand Plain (Cooper, 1935) and the area around it is now considered to be a late senescent bog (Lindeman, 1941). In this bog there are many plants usually found either farther to the north or at higher elevations.

Lindeman (1941) discussed the vegetational succession surrounding Cedar Lake. The "sedge mat" surrounding the lake is composed of *Typha latifolia, Phragmites communis, Decodon verticellatus*, sedges, grasses, other herbs, ferns and mosses.

The first tree to invade the sedge mat at Cedar Creek Forest is tamarack (*Larix laricina*). This is followed by the white cedar (*Thuja occidentalis*) rather than black spruce (*Picea mariana*), which is associated with a more acidic bog. Swain and Prokopovich (1954) gave a pH range of 7.1 to 7.6 in fifteen samples taken along a stratigraphic section through the bog and lake.

The tamarack-white cedar area of the bog has fair populations of the red-backed vole. In the surrounding upland area of maple-basswood or northern pin oak (*Quercus ellipsoidalis*) red-backed voles are rarely taken during the summer (Gunderson, 1949, 1950). This site marks the southern limits of the voles' geographic distribution in Minnesota in any numbers.

Description of trapping area.—The trapping area was 468 feet square and contained 5.0 acres. This included half the width of the grid on all sides. The trap stations, numbering 81, were spaced 52 feet apart.

The tamarack-white cedar area was superficially homogeneous but for the purpose of this study was divided into finer categories. Two maps were made of the area. One was based on vegetation, the other was based on the distribution of stumps, logs and "blowdowns." A "blowdown" as used in this report was a tree leaning at an angle due to wind action. Its root system was partly exposed, and the tree might remain alive for several years. The root systems of the trees in the bog spread laterally rather than vertically. The result, when a tree was blown over, was that the exposed network of roots formed a matrix which was filled with soil mostly in one plane and leaning at about a 45° angle. This was quite a different habitat from that formed by a root system rotting in the ground.

The eastern edge of the area and the southern half of the western edge were white cedar with sparse undercover. Extending north through the middle of the area was a tract of mixed tamarack-white cedar. Toward the northern edge of the area this tract became narrow and extended northwesterly.

Between the white cedar with sparse undercover and the tamarack-white cedar mixture was white cedar with medium undercover. This undercover consisted of grasses, carexes, other herbs, mosses and ferns. Within this tamarack-white cedar area were wet open areas with cattails. Extending west between stations 27 and 28 was a small area of tamarack.

The white cedar area had sparse undercover but a heavy covering of forest litter and many stumps and logs. Blowdowns were most common in the tamarack-white cedar area. The vegetational cover is shown in Fig. 1.

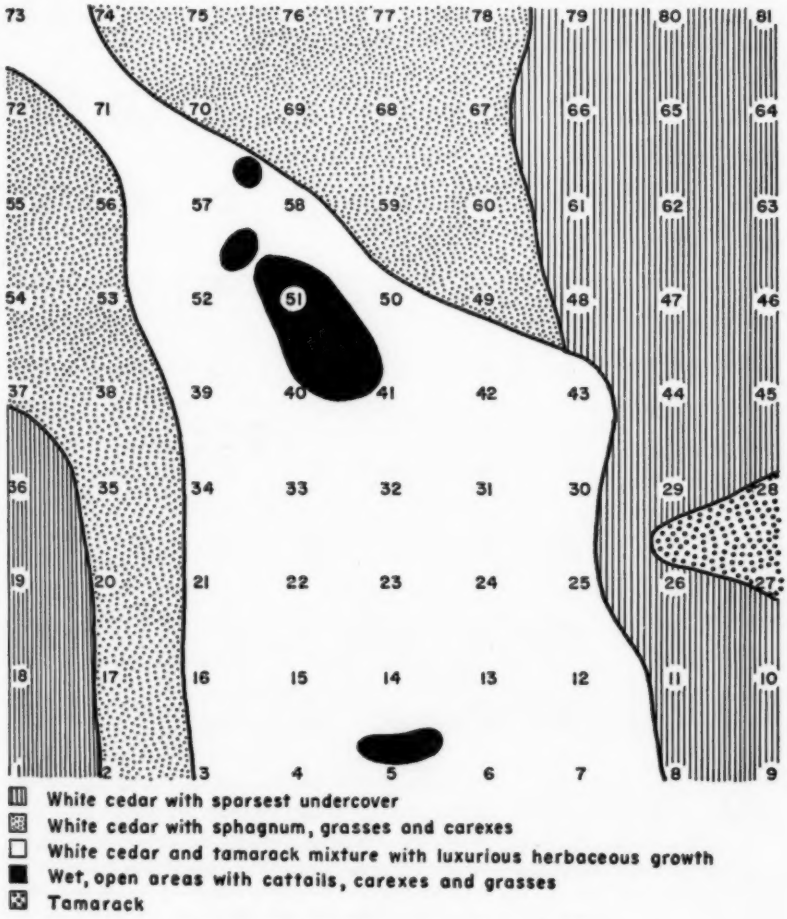
Methods.—Live traps used were the same as in an earlier study (Gunderson, 1950). They were made of ½-in. California redwood. The inside dimensions were 2 × 2½ × 8 inches. An inward sloping, hinged piece of aluminum formed the entrance. There were two entrance sizes, 1 and 2 inches high. Hardware cloth covered the rest of the front end of the trap. The door at the back end was a piece of aluminum fitted into slots.

When live traps are examined only once a day, I find less mortality in wooden traps than in metal ones. Cotton was placed in the live traps not only for nesting material but as extra insulation, needed in extremely hot as well as cold weather. Rolled oats was used as bait.

Trapping periods were at regular intervals beginning the first part of May and ending early in October; they were of four nights each. During the first four years trapping periods were every third week. During the last three years they were adjusted to get a sample at the end of winter, at the two peak periods

of emergence of young, and at the end of summer. Actual periods of trapping during each year are indicated in Table 1.

The mammals were marked by toe clipping as used by Burt (1940), Quimby (1951), Gunderson (1950) and others. Beginning with the clipping of only one toe, 18 individuals can be marked. Only four toes were used on each of the front feet. The inner toe on each front foot is so small that it would be easily overlooked if it were clipped. After No. 18 has been used, two toes must be clipped. Nearly 200 individuals can be marked in this manner without repeating the series. In this study it was necessary to repeat the series, but enough time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19 20 21 22 23 24 25 26 27
18 17 16 15 14 13 12 11 10
1 2 3 4 5 6 7 8 9
White cedar with sparsest undercover
White cedar with sphagnum, grasses and carexes
White cedar and tamarack mixture with luxurious herbaceous growth
Wet, open areas with cattails, carexes and grasses
Tamarack

FIG. 1.—Vegetational cover map of trapping site.

TABLE 1.—*Beginning dates of the four-day trapping periods during each of seven years*

MONTH	1949	1950	1951	1952	1953	1954	1955
May	11, 30	1, 24	7, 11, 28	13	5	11	2
June	28	13	19	3, 25	23	22	20
July	26	11	10, 31	—	15	27	19
August	23	7	21	5, 25	—	—	30
September	20	5, 26	11	15	1	15	—
October	18	17	2	7	6	5	4

elapsed so that it was felt no longevity data were lost. The marking was begun in May 1949, and the series was not repeated until October 1950. In all, 428 individuals were marked. There were 25 dead, unmarked individuals.

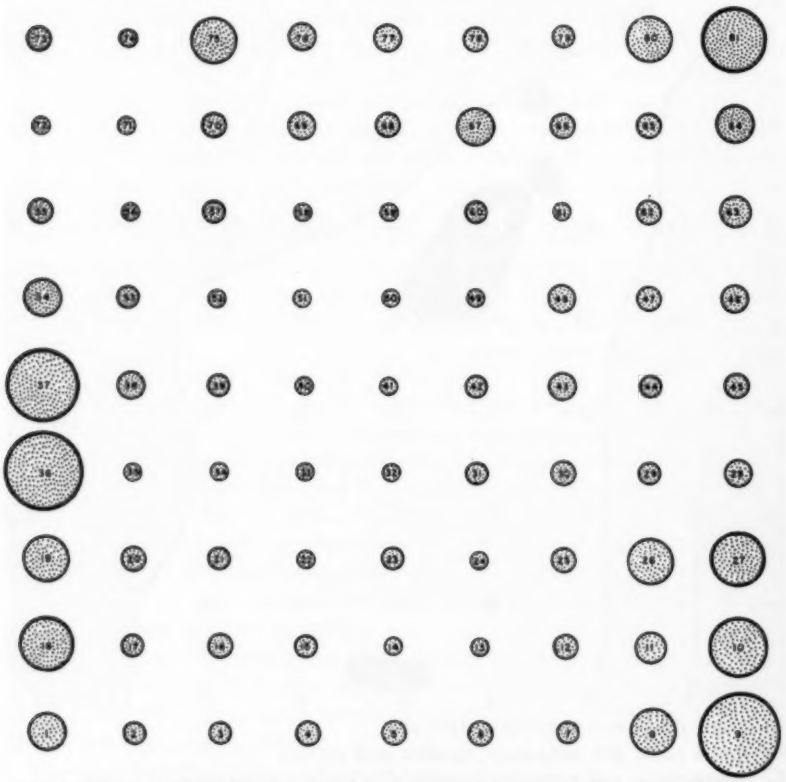

FIG. 2.—A map of trapping area showing frequency indices of each station. Numbers in circles represent trap stations. Size of circles indicates frequency index; e.g., in top row, from left to right, they represent indices of 40–60, 1–20, 120–140, 60–80, 60–80, 40–60, 20–40, 120–140, and 182.

Results.—The method of showing habitat "preference" was one used in an earlier study (Gunderson, 1950). A frequency index was computed for each trapping station. This index was determined by multiplying the number of individuals caught at a station by the number of years in which they were caught. Thus, the length of time an area was occupied, which presumably would be a characteristic of a more favorable habitat, entered into the index. These frequency indices were grouped by 20's, except the highest numbers which were not grouped. Corresponding sizes of circles represent these frequency indices on a map, Fig. 2. By comparing the frequency index map with the maps in Fig. 1 and Fig. 2, some factors affecting the distribution could be demonstrated.

We know that the availability of food and water influences distribution. With regard to food, Seton (1909) said of the red-backed mouse: "In food habits it is omnivorous." Merriam (1884) wrote that "It feeds upon beechnuts and a variety of seeds, berries, and roots, and also, at certain times in the winter season, upon the bark of shrubs and trees."

A need for water is evidently very important for *Clethrionomys*. Butsch (1954) wrote, "Local distribution appears to be controlled by the availability of free water rather than suitable food." Within the trapping site at Cedar Creek Forest, free water was available throughout the area—if not on the surface,

PLATE I

Photograph taken at station No. 9 which had the highest frequency index.

within a few inches of it. This seems to justify the conclusion that availability of free water was not a limiting factor at Cedar Creek Forest during the period of this study.

Comparison of the frequency index map with the vegetational map showed that the stations with the highest frequency indices were in the white cedar area with sparse herbaceous cover. The station with the highest frequency index was No. 9 (Pl. I) with a frequency index of 350 (7 × 50). Other stations in the white cedar area of the southeastern corner with high frequency indices were No. 8 (120), 10 (168), 11 (126), 26 (126) and 27 (154).

In the white cedar along the southern half of the western edge, station No. 36

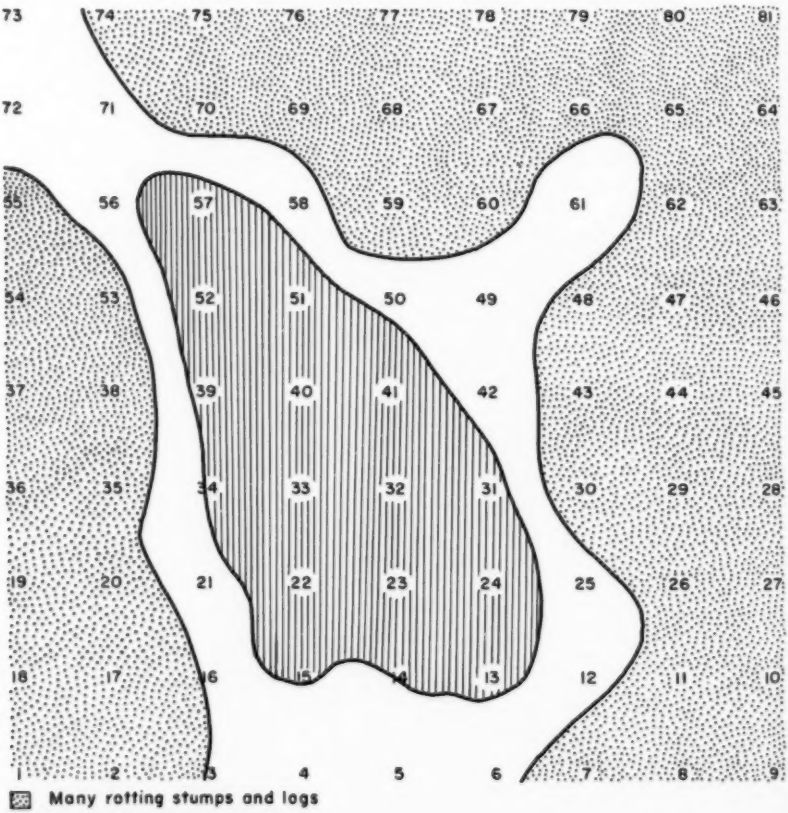

FIG. 3.—A map of trapping area showing distribution of stumps, logs and blowdown area.

had the highest frequency index (294) and No. 37, 216. Other stations in this area with high indices were No. 1 (115), 18 (140), 19 (132) and 54 (119).

In the northeastern corner, also with white cedar cover, station No. 81 had the highest frequency index, 182. Stations No. 46 (80), 63 (90), 64 (102) and 80 (132) also had high indices. Stations No. 75 (125), 76 (72), 77 (80) along the northern border of the trapping area, but outside the white cedar cover also, had fairly high indices.

Although the vegetative cover was sparse in all these areas, there was some slight variation. To find a closer correlation between some distribution factor and the frequency indices a third map was used. Figure 3 is a simplified map of the distribution of logs, stumps and down or partly down trees. I found (1950) that "The distribution of the Red-Backed Vole . . . indicated the preferred area was white cedar with sparse to medium cover. Apparently they did not find the luxuriant growth necessary for their runways, but used old roots and logs and runways along the roots and logs which penetrated or were buried in the forest floor." Burt (1940) and Davis, Emlen and Stokes (1948) believed that an important function of home range was protection against predators. At Cedar Creek Forest the roots of trees and stumps extended laterally (not vertically) into the peat and mosses. The soil is not tightly packed around the roots and this provided either ready-made runways and cover or easily excavated runways. Comparison of this map and the frequency index map show a close correlation. All stations with high frequency indices were in the area of most rotting stumps and logs. The stations with the lowest frequency indices were in the area of tamarack-white cedar with rather heavy undercover.

SUMMARY

These data are a part of a study of small mammal populations at Cedar Creek Forest, Anoka County, Minnesota. The live-trapping area of 5.0 acres, with 81 traps spaced 52 feet apart, was in a tamarack-white cedar bog. The study extended over a period of 7 years (1949–1955). Trapping periods of five days (four nights) extended from early May to the first part of October. In all, there were 14,580 trap-nights. A total of 428 voles were marked and weighed; data on 25 dead unmarked individuals are also included.

A frequency index was calculated for each station. This index was arrived at by multiplying the number of individuals caught at a station by the number of years they occurred at that station. These indices were grouped and represented on a map. *Clethrionomys* occupied mostly the white cedar area with sparse to medium cover. Within this area their distribution was most closely correlated with the presence of stumps, rotting logs and root systems in loose forest litter and sphagnum.

ACKNOWLEDGMENTS

This study was supported by Graduate School grant number 214-3201-219 of the University of Minnesota. Permission to work at Cedar Creek Forest was granted by A. N. Wilcox, director of Cedar Creek Forest. Appreciation for their assistance is expressed to W. J. Breckenridge, Bruce Hayward and John Jarosz for help in laying out the area; Bruce Hayward, John Jarosz and Gerald Robinson for helping from time to time with trapping, marking and recording; and Franklin Willis who did all the trapping during the author's absence in June, July and August of 1953, and who helped in the trapping at other times during the period of study. I should like to express my appreciation to Mrs. Helen S. Chapman, Museum Artist, who made the three figures.

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LONGEVITY NOTES ON CAPTIVE *PEROGNATHUS*

BY LAURENCE M. HUEY

As with most mammalogists the writer has, over a period of years, had captive pocket mice as pets. Two of these captives lived long enough to warrant recording the conditions under which they had lived, some of their habits during captivity and their known ages.

Perognathus parvus mollipilosus.—During July, 1917, the writer was camping near Vinton, Plumas County, California, collecting specimens for Donald R. Dickey. The telephone company, at that time, was replacing a few miles of their lines with new poles and a crew of men was digging holes across this rather wide valley. Inspecting these holes before the derrick set in new poles I was able to capture a number of desirable specimens. Among them was a beautiful adult female *Perognathus parvus mollipilosus* which I elected to keep alive as a pet. It was taken on July 3.

A small wooden cage of about 4 × 8 × 16 inches with a screen wire top was built. Sand an inch deep was placed on the bottom of the cage and a small pasteboard .410 gauge gunshell box filled with cotton was set inside to be used for a nest.

A few days later an adult male *Microdipodops megacephalus californicus*, captured in the same way, was confined in the same cage after a screen partition had been installed dividing the floor space. This animal lived only 14 months in captivity and its age length was not noteworthy. The only reason for mentioning the *Microdipodops* was its reaction to the presence of the *Perognathus* on the other side of the screen partition. Both species occupy common ground in the wild, where their attitude towards each other is unknown. However, in captivity, they fought nightly.

The allotted food given each one was always stored away from the screen partition, the *Perognathus* putting most of hers in the nest box while the *Microdipodops* deposited his first in one corner of his section of the cage, then in the other. This seemed to indicate the *Perognathus* used its burrow as an underground storeroom while the *Microdipodops* appeared to be a grass planter and made his caches on the surface of the ground. Both species seemed to take great care of their food stock, moving it often as they were observed with loaded pockets almost nightly.

Their greatest activity, however, was fighting. It was a battle of sand, which was pushed in a mound against the wire screen partition by either combatant which, when its mound was the highest, would watch its chance using its hind feet to kick sand at the opponent. Small portions of sand were thus thrown with remarkable velocity. The objective of this act seemed to be making an "eye shot," though in the many evenings I watched these sand-throwing animals I never observed any indication of injury suffered by either belligerent. The main results of this feud seemed to be exercise and often exhaustion for both.

There appeared to be a bit of cunningness involved in the fighting for when the nest boxes were disturbed or moved to a different position, when the sand was shifted, the belligerents hid from each other behind the boxes and played "peek-a-boo" awaiting the most opportune time to attack. This strategy reminded me of children at play, and involved peering from corner to corner. This action usually followed a vigorous sand-throwing campaign and served as a rest period to prepare for the next assault.

The principal food supplied these captives was packaged mixed bird seed, prepared for canaries and usually given in goodly volume every 3 or 4 months. At this time the cages were emptied of all sand, seed hulls and excrement, and clean sand and new seed (usually half a package to each) were installed. The cotton in the nest boxes was not disturbed when the cage was cleaned for the occupants kept their boxes clean and the cotton nest material well felted. In this regard the two were different. The *Microdipodops* was never observed to fluff his nest while the *Perognathus* often carried parts of her cotton outside where she shredded it and returned it inside—perhaps she preferred a soft bed.

This seed diet was at times supplemented with a few sprigs of pepper grass (*Lepidum*), when obtainable, and was greatly relished by both species, for after eating the seeds they both shredded the stems for moisture and added the stalks

to their nests. This was the only food containing free moisture that was ever given; nor was water ever supplied during their captive lives.

These two caged animals were carried during two collecting seasons, from one end of California to the other and from the desert to moderate altitudes of the Sierra Nevada without apparent difficulties.

The *Microdipodops* died the summer following his captivity and was not discovered dead until too late to preserve as a specimen. After the second summer the *Perognathus* was left with Frank Stephens in San Diego. Mr. Stephens built a larger cage with the idea of having the pocket mouse for a living display in the museum. The food he gave the mouse was wheat and sunflower seeds and no green fodder of any sort.

The *Perognathus* was found dead in its cage on December 27, 1921, after 4 years 6 months in captivity. During this long period it had lived principally on dry food without water.

Critical examination of the skull and comparison with other cranial specimens of the same species revealed no unusual rugosity or overworn molars. The heavy chewing required by large hard wheat kernels and heavy husked sunflower seeds had caused no apparent excessive development on the muscle processes or excessive wear on the mouse's teeth.

Perognathus fallax fallax.—The subject of this note was captured in a tin-can live trap on June 8, 1942, at Hillsdale, southeast of El Cajon, San Diego County, California. It was a male and fully adult at the time of its capture. A cage of $8 \times 12 \times 24$ inches with a screen top and two glass sides was built for this mouse. The glass sides were installed with intentions of photographing the captive, but this purpose was never consummated.

A small nest box of $4 \times 4 \times 4$ inches, made of soft pine with a ¾-inch hole bored for an entrance, was set unfastened within, and sand 3 inches in depth was placed on the floor of the cage. Loose cotton installed for nest lining was quickly gathered and carried into the nest box by the mouse. This cage was placed on the concrete floor of my garage where it remained during the entire life of the mouse. Temperature conditions, as a result, were nearly those of its native habitat, with perhaps the lack of wind.

This mouse had no companions within the cage though signs outside revealed the fact that house mice were occasionally about, though they were never observed. As a result the attitude of this *Perognathus* toward other mice could not be recorded. Through the years, however, several mannerisms of this captive were seen.

A tap on the glass side with one's finger always brought him out of his nest, if only to peek. At such times only his head would appear from the nest box hole. He twisted his nose about, his long whiskers vibrating as if sampling the air for the scent of an enemy. Occasionally, after the preliminary peek, upon seeing the finger he rushed over to the glass and started kicking sand at the finger with his hind feet, just as the other species had thrown sand at each other.

I usually gave this mouse an entire box of canary seed at one time which

caused considerable activity. He also took great care of his stock of food, most of which, when it was given to him, he stored in his nest box. Often the amount was too great and the portion left outside was placed in one corner of the cage and covered over with sand. The seeds stored outside were eaten first for, upon finding his outside cache exhausted, I cleaned the cage by dumping all sand and seed shells out, replacing with clean sand and new seeds. At such times the nest box still contained an abundant hoard of uneaten seeds. I never found seed hulls within the box nor was excrement ever found within his nest. Like the forementioned two species, this mouse was always sleek and clean, due, no doubt, to an abundance of clean sand to dust in.

His sanitary habits were also exemplary. All three captives seemed always to use a single corner of their cages for a toilet.

This *Perognathus* was found dead in his cage on October 14, 1950, after 8 years and 4 months in captivity. During this time, an occasional bit of seed-bearing grass found in the garden was given him, but never a single drop of free water.

Posthumous examination of the skull revealed no excessive rugosity. There was, however, a decided roughness on the dorsal surface of the audital bullae when compared with field-taken specimens. While the teeth were worn to a flattened surface they were not extremely so, as is often the case in field-collected specimens taken in a coarse gravelly region. The flattened worn surface of the teeth, when correlated with the known age of this mouse, serves as a very useful index when determining ages of other members of the same species.

San Diego Society of Natural History, Balboa Park, San Diego, California. *Received October 28, 1957.*

FOOD HABITS OF THE DEER MOUSE

By Olwen Williams

Although many investigators have contributed to our knowledge of the food preferences of small mammals, considerably more precise information is needed. This information will add measurably to our understanding of ecological distribution and will be of considerable practical value to foresters and others (Jameson, 1952).

The present paper deals with the results of a limited study of the food habits of two subspecies of the deer mouse, *Peromyscus maniculatus*, in five areas in Wyoming and two in Colorado. The animals from Wyoming were assigned to *P. m. artemisiae*, while those from Colorado were identified as *P. m. osgoodi* or as intergrades between *osgoodi* and *rufinus*. The field work in Wyoming was carried on from the Jackson Hole Biological Research Station in Moran, the facilities of which were generously made available in August, 1955. I wish to express my appreciation to Dr. L. Floyd Clarke, director of the station, for this courtesy.

Methods.—The mice were obtained in the field by snap-trapping. As soon as possible after taken, their stomachs were removed and the contents washed in moderately hot water to remove fat and gastric juice. The contents were then screened through a piece of fine bolting silk and the residue examined under a dissecting microscope in a small amount of clean water in a watch glass. Because time in the field was limited, many of the stomachs could not be examined immediately. After washing, the contents of these stomachs were dried on pieces of blotting paper and stored in envelopes for further study. Before examination, they were placed in 5 to 10 milliliters of water in a small beaker and boiled for about one minute. This very nearly restored their original wet appearance. This simple technique constituted a distinct improvement over a procedure formerly used in which untreated, dried or formalin-preserved materials were examined directly (Williams, 1955). Drying or preserving often so changes the appearance of the stomach contents that their identification is rendered more difficult.

The most satisfactory examinations were those of fresh material. The fresh contents of at least a few stomachs from each series were examined in the field. A careful survey of the trapping area to determine the kind and appearance of possible foodstuffs available helped with the identification of many of the items in the stomachs. In every case, the stomach contents were examined twice. First, the materials were identified on a qualitative basis; second, a volumetric estimate was made to the nearest 5 per cent for each item. Following this, for each series as a whole, the mean of the volumetric estimates and the frequency of occurrence of each item were calculated. The lack of accuracy inherent in this procedure was considered unimportant because of the limitations of stomach analyses for strictly quantitative studies of food habits.

RESULTS AND DISCUSSION

Series I: The first stomachs examined were from 11 *P. m. artemisiae* trapped at Jackson Hole, Wyoming, during the first week of August, 1955. The vegetation at the site consisted of the dominant sagebrush (*Artemisia*) and a variety of grasses and forbs. Most of the latter were in seed and many of the plants were beginning to dry up. The community was bordered by an open stand of lodgepole pine (*Pinus contorta*), and a few of the trees were near enough to be within the home ranges of some of the animals caught.

As indicated in Table 1, seeds accounted for 69 per cent of the material found in this series (mean volumetric estimate). About one-half of the stomachs contained pine seeds; all contained the seeds of forbs. Specific identification of many of the latter was impossible. While the pine seeds, although chewed into fine fragments, could be recognized by the presence of the nearly intact nucellar beaks, the seeds of the forbs lacked distinguishing characteristics because the mice had discarded the seed coats. For the most part, the seeds could be identified only as those of dicots, but in a few cases a wild buckwheat or a mustard appeared to be the source.

Arthropod remains were the other item of considerable importance. Twenty-eight per cent of the material in these stomachs consisted of the remains of adult and larval insects and of arachnids. Two-thirds of this volume consisted of the chitinous remains of beetles and ants. Little green vegetation was present in the stomachs. Mouse fur and mineral fragments complete the list of items present. It may be assumed that both were eaten inadvertently; the fur, compacted into distinct balls, was probably swallowed during grooming, and the mineral fragments may have been picked up with the seeds and arthropods from the surface of the soil.

TABLE 1.—*Summary of analyses of the stomach contents of 122 deer mice. Figures in parentheses are frequencies of occurrence; other figures are mean volumetric estimates calculated to the nearest 1 per cent; + indicates trace only*

FOODS	SERIES NUMBER						
	I	II	III	IV	V	VI	VII
Seeds, total	69	66	70	79	33	71	76
Conifer	25 (55)	63 (100)	69 (100)	63 (100)	33 (84)	14 (18)	76 (100)
Others	44 (100)	3 (17)	1 (25)	16 (60)	+ (4)	57 (86)	—
Fruit	—	—	—	—	50 (88)	—	—
Green vegetation	+ (45)	14 (78)	7 (68)	2 (73)	1 (12)	18 (95)	—
Fungi	—	—	12 (64)	6 (20)	1 (12)	+ (5)	—
Annelids	—	—	—	—	—	+ (27)	—
Arthropods, total	28	13	8	13	15	11	14
Insect larvae	10 (45)	3 (22)	2 (12)	3 (33)	12 (64)	3 (64)	8 (66)
Insect adults	18 (100)	7 (78)	5 (92)	3 (80)	+ (48)	3 (82)	4 (50)
Arachnids	— (9)	3 (55)	1 (28)	—	3 (24)	5 (45)	2 (33)
Woody fragments	—	+ (11)	1 (32)	+ (6)	+ (4)	+ (5)	8 (83)
Mouse fur	3 (36)	7 (55)	2 (20)	7 (40)	+ (16)	+ (23)	2 (100)
Miscellaneous	+ (100)	+ (100)	+ (100)	+ (100)	+ (100)	+ (100)	+ (100)

Series II: This series comprised 18 stomachs from mice caught between a dense spruce-fir forest and an open subalpine meadow at an altitude of approximately 9,600 feet near Togwotee Pass, Wyoming, on 6 August 1955. The forest trees were Engelmann spruce (*Picea Engelmanni*), subalpine fir (*Abies lasiocarpa*) and a few whitebark pine (*Pinus albicaulis*). In the forest, the mineral soil was almost hidden by a heavy cover of whortleberry (*Vaccinium*), lupine (*Lupinus*), paintbrush (*Castilleja*), lousewort (*Pedicularis*) and arnica (*Arnica*). In the open areas of the meadow, through which flowed a small stream bordered by a low thicket of willow (*Salix*), were grasses and sedges, clover (*Trifolium*), lupine, *Senecio* and *Eriogonum*.

In this habitat, seeds again constituted the main dietary item. Sixty-six per cent of all the material examined in this series fell in this category with the conifers providing most of it. The whitebark pines were dropping a heavy crop of cones. Green vegetation and arthropods accounted for 14 per cent and 13 per cent, respectively, of the materials in the stomachs. Mouse fur and a few miscellaneous items such as mineral fragments and a feather made up the remainder.

Series III: In this series, 25 stomachs from animals trapped on 9 and 10 August 1955, in a spruce-fir forest in the Togwotee Pass area, were studied. The vegetation was similar to that described for Series II. In addition, there was much down timber rotting on the ground. The habitat was moist with a thick layer of leaf mold covering the mineral soil.

Seeds constituted 70 per cent of the material present in the stomachs; all but a small amount was of coniferous origin. It was felt that the whitebark pine was almost exclusively the source of these seeds. The number of large nucellar beaks in a single stomach varied from 1 to 5 and averaged about 4. Invariably, the mice discarded the woody outer coat of the seed but ate the thin, inner integument.

Fungi comprised 12 per cent of the stomach contents in this series. Arthropods were conspicuous in the list of items found in the stomachs, making up 8 per cent of the total. Green vegetation, mouse fur, and mineral fragments made up the remainder.

Series IV: A trap-line set on 12 August 1955 in a pure stand of whitebark pine at approximately 9,600 feet in the Togwotee Pass region yielded a total of 15 deer mice for this series. This habitat was drier and more open than the neighboring spruce-fir forest. Herbaceous plants made up a larger part of the ground cover although the vegetation was very similar. Lousewort, lupine, paintbrush and columbine (*Aquilegia*) were the most abundant herbaceous plants.

The stomach analyses were quite similar to those in the two previous series. Seeds, presumed to be mostly those of whitebark pine, comprised 79 per cent of the material examined. The percentage of seeds derived from forbs and grasses was greater than in Series II and III. Arthropod remains, consisting of the chitinous fragments of insects, made up 13 per cent of the total, while fungi accounted for another 6 per cent. The presence of the latter was somewhat surprising in view of the relative dryness of the habitat, but some of the timber on the ground was infested with fungi of different kinds.

Series V: Twenty-five mice provided the material for this series. They were trapped from 17 to 19 August 1955 in a pure, rather open stand of lodgepole pine near the south gate of Yellowstone Park where the highway crosses the Snake River. This forest was burned about 1928. All of the standing trees were fire-scarred, and nearly one-third of the original trees were dead. Many had fallen to the ground. The result was an open forest beneath which a dense ground cover had developed. This cover consisted, for the most part, of an extensive growth of red whortleberry with scattered shrubs of snowberry (*Symphoricarpos*), buffalo berry (*Shepherdia*) and many herbaceous species including grasses and strawberry (*Fragaria*). The strawberry and whortleberry were producing fruit in quantity, as were the taller snowberry and buffalo berry. Fifty per cent of the material from the stomachs in this series consisted of strawberry and whortleberry fruit, the latter being present in greatest amount. A number of the stomachs were crammed solely with ripe whortleberry fruit. None of this fruit appeared to be eaten green, and none of the stomachs contained the abundant snowberry and buffalo berry fruits.

Seeds, mostly coniferous in origin, comprised 33 per cent of the total volume of material. This was somewhat surprising, since lodgepole pine cones containing seeds were not plentiful on the ground. A few pine squirrels (*Sciurus fremonti*) were seen cutting and dropping new cones to the ground, but the new ones that were examined showed no evidence of having been worked over by mice. Possibly the mice had access to caches of cones or seeds that I did not see.

Arthropods made up 15 per cent of the material examined. Beetle larvae were the most commonly observed arthropods; one stomach contained more than 40 individuals. The remainder of the items included small amounts of green vegetation, woody fragments, and mouse fur.

Series VI: This series comprised 22 stomachs from a Colorado plains community near Marshall Lake, southeast of Boulder, taken during the third week of April, 1956. The vegetation of this community consisted of grasses and forbs with numerous clumps of yucca (*Yucca*). A few scattered ponderosa pines (*Pinus ponderosa*) stood at one end of the trap-line.

Seeds made up 71 per cent of the stomach material; about one-fifth was conifer seed. Four individuals trapped near the ponderosa pines were responsible for this figure; their stomachs were filled with pine mast. The remaining four-fifths of the seed material were derived from grasses and forbs.

Green vegetation accounted for 18 per cent of the material, possibly because of the succulent spring plants. Arthropods constituted another important item, half of which was spider remains. Other items included fungi, wood fragments, fur, mineral particles and earthworms. Nearly 25 per cent of the stomachs contained some remains of earthworm. Their availability was probably enhanced by a gentle, warm, spring rain which brought them to the surface.

Series VII: Six stomachs obtained in a ponderosa pine community in Bummers Gulch, roughly 8 miles west of Boulder at an altitude of 8,000 feet, during the first week of May, 1956, constituted Series VII. The area also contained scattered Douglas firs (*Pseudotsuga taxifolia*). The ground cover comprised such shrubby species as common juniper (*Juniperus*), waxflower (*Jamesia*), kinnikinnick (*Arctostaphylos*), buffalo berry, and a number of herbaceous plants. A few of the herbaceous species, such as golden banner (*Thermopsis*) and the pasque flower (*Anemone*), were beginning to flower.

A limited food supply was suggested by the stomach contents. Conifer seeds made up more than three-fourths of the bulk of the food examined. Arthropods, mainly insects, constituted 14 per cent, woody fragments 8 per cent, while mouse fur and other items made up the rest. The presence of more than 100 nucellar beaks in one stomach gives some idea of the number of seeds that may be consumed by a single individual. The consistent use of conifer seeds, in areas where they are available, appears to be of considerable significance and has been reported elsewhere (Curtis, 1948; Jameson, 1952).

SUMMARY

Analyses were made of the stomach contents of 122 deer mice, *Peromyscus maniculatus*, trapped in five areas in Wyoming and two in Colorado in 1955 and 1956. Starchy interiors and integuments of seeds comprised roughly two-thirds to three-fourths of the material found in the stomachs examined. Conifer mast was an important item. One-tenth to one-fifth of the material identified consisted of insect and arachnid remains. Grubs and caterpillars were frequently represented. Fruits, fungi, annelids and green vegetation comprised the other foods identified.

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Dept. of Biology, Univ. of Colorado, Boulder. Received November 15, 1957.

GROUP DYNAMICS IN WYOMING MOOSE DURING THE RUTTING SEASON

By Margaret Altmann

A comparative study of free-living ungulates, in respect to their social organization (Altmann, 1956) showed that the Wyoming moose, *Alces alces shirasi*, exhibits both strong solitary phases and other periods of social integration within one seasonal cycle. Closer analysis of the group dynamics of the Wyoming moose was undertaken in this study. The focus of our special attention was on the periods of changing social structure in the rutting season. Despite the significance of this period, there are only a few reports (Denniston, 1956) of behavior patterns of moose during this time.

The present paper deals with the dynamics of the moose rutting season which starts in early September and extends through late October in the area of our investigation. But a thorough study of the social aspects of moose behavior during any particular part of the year will have to be drawn against the background of the whole yearly cycle.

The general picture of the moose year in the Rocky Mountain area is as follows. Toward spring, with the snow still on the ground, the loosely knit winter associations (aggregates) of the moose (3 to 12) begin to disintegrate. The bulls remain alone or in small bands with younger bulls, called "satellites" in this study. The satellites distinctly follow the leading bull at a distance of a few to 25 yards. The bull moose are in the antler-growing velvet stage during this period. They avoid any conflict with the territorial, calf-defending moose cows. The moose cows, still accompanied by their yearlings, leave the social aggregates and seek out secluded locations favorable for parturition. In May and early June the calving season of the moose is under way. About two weeks before this time, the yearling is expelled. We found, in accordance with Denniston (1956), that the moose cow maintains a zone around the calf which she defends against any intruder, be it her own species or another.

Procedure.—Moose were located and observed from hidden vantage points without disturbance. Whenever possible, each individual moose was recorded by noting natural or artificial markings.

Natural markings in moose are relatively numerous and clearly defined. The variation of "bell" shape and size as well as pelage color on head and shoulders in both sexes and the antler shape in males made possible a fair recording of individuals. In some cases, artificial marking of individual moose was done by crossbow, and the paint or dye-spot was recorded within a rubber-stamp outline in the notebook, as in the accompanying figure. This technique still needs improvement, since pelage does not retain the paint marks for long. A self-marking device for moose was also constructed (Taber *et al.*, 1956) but was used only in limited periods of this study.

Once located and recorded, the moose groups or the individual moose were kept under observation for days or weeks in order to follow activities and changes in association. Four main areas were used for this study. Two were in National Forest (hunted) areas and two were in National Park (protected) areas. There were 2,139 moose observations recorded in 1955 and 1956. The duration of the observations varied from 30 minutes to 3½ hours. Frequently the observations were carried out in alternating shifts so that no important activities would be missed. During some phases of this work, two graduate students served as assistants—Mr. James Ruos, University of Wyoming, in 1955, and Mr. Patrick Capretta, University of Colorado, in 1956.

Most of the material for this study was secured from May to November. The winter situation of moose in this area (November–April) was relatively well known (Harry, 1957). Since the moose invade the lower drainages of Jackson Hole at that time, there is also ample contact and interaction with the local ranchers. In fact, most of the local knowledge of moose behavior stems from a generalization of the winter situation and is summed up in the words: "A mean and tired moose is blocking the driveway or trail to the haybarn." From the standpoint of social behavior, the winter group offers less interest since the very compelling circumstances of hunger and cold limit other manifestations of activity.

Observation from slopes or overlook points was usually preferred to close stalking. Long sequences of social behavior in big mammals can best be followed from a distance, while the trend of beginners is usually to try to get close, a method certain to result in "spooking" the game. Saltlicks, ponds and regular moose trails also proved valuable for making observations at certain seasons. Recorded on the spot was undisturbed behavior, as well as behavior under stress of natural or man-made disturbances. In the latter case, the hidden observer witnessed the disturbance but did not actively participate in it. For example, tourist influx, road noises, a cattle drive, migrating elk groups, or a bear passing by, were all disturbing factors. Such situations of stress frequently revealed the social organization of a group that otherwise might have appeared "noncommittal" as to its structure.

Equipment.—For survey and scanning, a pair of 7 × 50 field glasses (lightstrong) were used; for detailed behavioral observations, a 30× Balscope Sr. on a tripod proved best. The observer was on foot or on horseback.

Observations.—During the pre-rutting stage in August, the bull moose gradually withdraw from their younger group companions, the satellites, while the now fully developed antlers are rubbed against shrubs and trees, freeing them of the drying velvet. There is much mock-fighting and display-chasing among the bulls. Their habitat changes from the open willow flats to the timbered slopes of the foothills. In the younger bulls, antler changes and onset of the rut occur three to six weeks later than in the older bulls. There are a few exceptional cases of extreme dates of moose rutting in early August and in December.

In September, the mature bulls emerge from the timbered areas with shiny,

white-tipped antlers. They are now solitary and in the searching stage of the rut. Willow-studded flats spotted with aspen and cottonwood stands are screened by them in search of a moose cow in estrus or of a rival bull. Tension, as seen in "formal" activity and interrupted feeding, is gradually mounting. Density of moose in a suitable rutting habitat is increased above normal. In the main observation area of about 3 square miles, an average moose population of 8 to 10 head per square mile was observed during this study.

The cow is also drifting through the area. Her search is characterized by the loud, plaintive call for the bull. The bull will answer such a call with immediate approach and with continuously uttered short grunts. The search ended, the bull enters the stage of display and driving or following the cow, a form of courtship. In the display stage, the bull stands for hours, usually sidewise, 3 to 5 yards from the cow. The space selected for this display is free and visible for a long distance. While the cow continues to browse and graze, the bull stands motionless as if posing. When the cow moves further ahead, he will take up another position directly in line of her movement. This display stage lasts about one to three days, then the "driving" or "following" stage is in evidence. Even in this stage the cow determines the direction of moving; the bull walks step by step right behind her. Still unwilling to stand for mating, the cow moves on.

If any other bull invades the area to within 60–100 yards, he is challenged, and if he does not retreat, a fight is staged. In most cases, one of the bulls yields without a fight; only when the rivals are fairly equal in weight and aggressiveness, will a battle ensue. The cow and her calf, now about four months old and still nursing, stand by, often browsing.

Special behavior patterns of the bull, connected with the rutting period, may include:

1. The build-up, challenger gait, swaying gait with the heavy antlers dipping from side to side, executed in stiff, long strides, usually in formal circles around the rival bull.

2. The mock-battle: hitting and shredding trees and shrubs before the beginning of the fight. During these stages it is still possible for one of the rivals to withdraw.

3. "Displacement" feeding, either browsing or grazing with hasty, jerky movements and exaggerated intensity, eyes fixed on the opponent.

4. Reinforcement of drive: (*a*) Occasional return to the moose cow, sniffing her and curling up of the upper lip, head raised high. (*b*) Activation of a wallow or making a new wallow and rolling in it. (*c*) Hitting and rubbing shrubs and young trees with the antlers, an apparent stimulation.

5. The fight, or the rival's decision to yield.

The battle of two bull moose is carried out as a constantly fluctuating affair. The pushing antler action of one bull is received by yielding movements of the opponent, but after six to eight steps or more backwards, the yielding bull braces himself and pushes forward. If one of the opponents slips or stumbles, he may be hit in the ribs or flank; this hurts enough to cause him to run off.

The battle may end with the rapid withdrawal of the beaten opponent (most cases) or a gradual stalemate. In the latter case, the two rivals begin displacement activities, browsing, grazing or tussling in the shrubbery and keeping each other under tension for hours, and in some cases for days, until one of them leaves the area definitely. The cow stands quietly or browses nearby during the whole conflict.

6. The driving and mating stage: the bull drives the cow, mounts her and, if she stands, copulates repeatedly during several days. At this stage the previously exhibited patterns of display, mock battles, wallowing and displacement activities are still intermittently executed, but do not predominate. The driving and mating phase lasts only a day or two. How long the cow is in heat and when ovulation occurs is not known.

The battle of females.—A young cow moose intruding into the area of a mating group will find a mature cow with calf as a vicious opponent as soon as she approaches closer than approximately 50 yards. Ears folded back and head stretched forward, the older cow tries to beat the intruder cow with her forelegs and cut her way off. The hair stands up on the humped back, the movements are rapid and jerky. Even the calf reacts in the same way as its dam toward the intruding cow, but does not actually hit the intruding female. This fight of cows is accompanied by weird facial expressions, head shaking and a play of ears. It reaches a climax when the cows enter a fresh moose wallow in the area, prepared by the bull.

The bull activates the wallow with his urine and by stamping, scratching and rolling in the mud. When the fighting cows reach such a fresh wallow, one of them tries to lie down in it and is immediately beaten and pushed out of it by her opponent. Once a mature cow has placed herself in the wallow, she tries to stay in it, lying low and covering as much of the surface as she can with her body. Her calf succeeds in squeezing into the wallow, too, close to her flanks. The intruding cow tries vigorously to dislodge the occupants of the wallow. At intervals the mature cow gets up to drive and beat the other cow away, only to return and roll in the wallow. The bull stands in full sight during such events, in display, but does not interfere or participate in the fighting.

Young bulls.—Partial tolerance of a young male by the bull in the rutting season is found in cases where such a male stays in the fringe area of the cow but does not attempt to approach and smell her nor to show any other courtship behavior. Such a young bull may be a yearling or a two-year-old son of the cow, and remains in the outer fringe of the mating group. Upon occasion, however, when the big bull is engaged in battle or is in pursuit of a yielding rival moose, the young (tolerated) moose may approach and court the cow. The big bull will then quickly turn and chase him in a rage; he may even interrupt a battle for a moment to put the youngster in its "proper distance," and then resume the fight.

In general, the bull stays with one cow at a time for approximately 7 to 12 days. This does not preclude occasional driving and mating with another cow

nearby. The bull will, however, return to his original mate and continue or complete the patterns described. In such cases the cow usually waits for the bull near the wallow.

With the end of the cow's attraction for the bull, the whole pattern of search, display, defense, driving and mating is repeated with successive cows until, in late October or early November, the unrest of the rut gradually fades out. The bulls are spent. They recuperate with long hours of resting and feeding while the loose aggregates of the winter groups are assembling in the willow bottoms of the lower river drainages.

Young bands.—The occurrence of young moose bands, groups of two to five, becomes more obvious in the fall months. They form the nucleus of the winter aggregates and are joined by cows with calves and by other unattached moose. These young bands browse and graze together, often widely spaced. They move in unison, sometimes conspicuously in single file, conduct mock battles and pursuit games. Most of the members are young bulls, two and three year olds, but some young females are in the groups and partake in the running games, although rarely in the mock battles. These bands are very mobile and cover more ground than solitary moose. They do not collide with the big bulls in rut and they avoid approaching the mating groups.

If a new member approaches or joins the band, exaggerated grazing is displayed; this seems to be a manifestation of non-aggression or friendly approach. Heads down and grazing, the various members come closer until the newcomer is within the group. The same pattern of "approach grazing" is used when a minor moose meets a mature animal. The young moose will graze its way close to the attentively watching older moose and thereby avoid a challenge.

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[This study was supported by a grant from the National Science Foundation, 1957.]

Jackson Hole Biological Research Station, Moran, Wyoming. Received November 23, 1957.

EFFECT OF HABITAT DISTURBANCE ON A SMALL MAMMAL POPULATION

By Joseph LoBue and Rezneat M. Darnell

The effect of farming disturbances on small mammal populations has received little attention in the literature. Lantz (1907) stated that "thorough cultivation of fields tends to keep down the number of voles," whereas Johnson (1926) noted that habitat disturbances produced by "cultivation of the soil" had little effect on prairie deer mouse populations. More recently, Linduska (1950) reported the results of an extensive study of the ecology of small mammals and its relation to land use. From limited sampling of a considerable number of different types of cropfields he found an increase in deer mice after harvesting of the fields. Meadow voles, on the other hand, were found more consistently in the sod borders adjoining the cropfields.

The present study was designed to determine in more detail the reactions of small mammal populations to destruction of the vegetative cover of a cropfield. To accomplish this end, it was proposed to proceed as follows. Study and analyze a population of small rodents in a relatively uniform habitat (an alfalfa field), then destroy the vegetative cover (harvest the alfalfa) and determine changes in population characteristics during and following habitat disturbance. The area under investigation was relatively small, and it was planned that the disturbance would be completed in a short period of time affecting the entire study area simultaneously. Because of the threat of inclement weather during the cutting period, however, the property owner decided that the field should be cut in three separate strips (enabling him to salvage the alfalfa crop which might have been lost if rain had prevented it from drying properly). The occurrence of three different times of cutting, rather than one, resulted in a shortening of the post-disturbance period of the field study and reduced, to some extent, the clarity of the comparison of pre- and post-disturbance populations.

General description of study area.—The main study grid (Fig. 1) was a 4.9-acre plot in the northern quarter of a 20-acre alfalfa field located near Cedarburg, in Ozaukee County, Wisconsin. The field had been utilized for an alfalfa crop since 1954 and had undergone one cutting late in June, 1956. Hence, when the study was initiated, the field had been free from farming activities for more than a month. The field was bordered on the north by a ditch-bank and a gravel road, across which was located an oak-maple forest. To the east, the study area was limited by a plowed field with no vegetative cover. The western edge of the field was bordered by a drainage ditch which contained water throughout most of the study period, maintaining a lavish growth of tall emergent hydrophytes.

The drier edges of this ditch (Area 2, Fig. 1) supported a dense growth of redtop and quackgrass, whereas growths of timothy dominated the northern edge of the field (Area 5, Fig. 1). Bushes and small trees were present along

the northwestern corner and this area appeared to be of major significance in the ecology of the local rodent populations. The importance of these so-called "edge areas" in terms of small mammals has been indicated by Johnson (1926), Linduska (1946; 1950) and others. The grid area proper contained a relatively uniform cover of alfalfa, although two small areas of different vegetative character could be distinguished (See *A* and *B* in Fig. 1).

MATERIALS AND METHODS

Field procedure.—The present study was carried out from July 22 to October 15, 1956. Within the main study area, a grid system of trapping was employed, using 255 double-door live traps of original design (LoBue and Darnell, 1958) placed at 30-foot intervals.

The grid was live-trapped, either wholly or in part, for 35 days; during this time the traps were tended at about 8 AM and reset at approximately 4 PM of each trapping day. Captive animals were toe-clipped and released. Live-trapping on the grid was halted

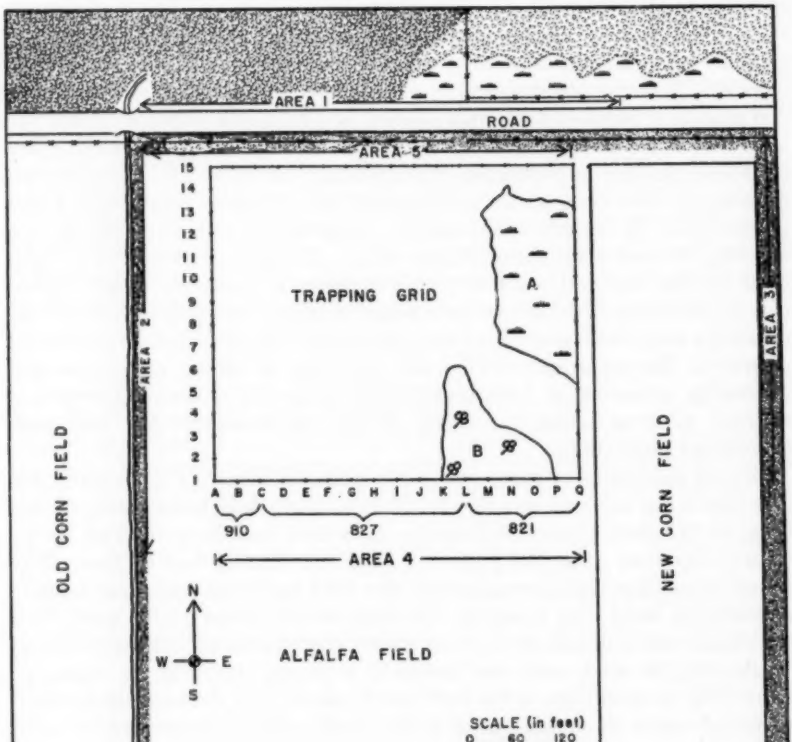

FIG. 1.—General map of the study area. See text for details. *A*, area dominated by tall grasses; *B*, area dominated by red and white clover.

September 24, and snap trapping was initiated on October 1. At this time 85 snap traps were placed on the grid at intervals of 90 feet with 30 feet between rows, and the grid was trapped for six consecutive days to remove the small mammals.

In addition, certain adjacent areas were live-trapped at intervals to provide information of the extent of movement to and from the grid. Standard, single-door traps (see Gunderson, 1950) were employed in adjacent area trapping, and captive animals were marked and released as described above. Snap trapping was initiated in adjacent areas on September 22 and continued until October 15.

Method of vegetation analysis.—During the study information was obtained concerning average maximum height, average per cent cover, and species composition of the grid vegetation. Average maximum vegetative height was determined from periodic measurements of the maximum height of a number of clumps of vegetation at each trapping station. Average per cent cover was ascertained by estimating the per cent of ground surface hidden by vegetation included within yard-square quadrats. Species composition was determined from quadrat studies.

Method of habitat disturbance.—The trapping grid was composed of 15 tiers and 17 rows of traps (Fig. 1). On August 21, six rows of traps (L–Q) were removed, and the area was cut. This cut portion of the grid is called section 821 since that date marks the end of the predisturbance period for the first six rows. On August 27, the remaining 11 rows were removed (A–K). Only that section of the grid corresponding to the area formerly occupied by eight rows of traps (D–K), however, was cut. This is called section 827. On September 10, the vegetation on the remaining segment of the grid (A–C) was cut and is referred to as section 910.

The cutting of each section was completed in one day. The cut alfalfa was allowed to remain on the ground from two to four days until sufficiently dry, and baling and removal of bales was accomplished in a single day in each case. Following this, live trapping was renewed on each section.

VEGETATION

During the predisturbance period grid vegetation was uniform and achieved a height of 26–30 inches. Cutting reduced vegetative height on all sections to 4 inches. Following the cuttings, vegetation on sections 821 and 827 grew to approximately 12 inches, whereas vegetation on section 910 showed no appreciable increase.

Predisturbance cover was 57 per cent on section 821, 87 per cent on 827 and 98 per cent on 910. Immediately following cutting, considerable ground cover was produced by the cut alfalfa. After raking and baling, however, cover on all three sections was practically

TABLE 1.—*Summary of the results of 32 quadrat samples of the vegetation of the trapping grid*

SPECIES	PER CENT OCCURRENCE		
	Sec. 821, 10 quads	Sec. 827, 17 quads	Sec. 910, 5 quads
Alfalfa, *Medicago sativum*	100	100	100
White clover, *Trifolium repens*	60	60	100
Foxtail, *Setaria* sp.	60	55	—
Dandelion, *Taraxicum* sp.	40	40	100
Ragweed, *Ambrosia* sp.	20	46	—
Red clover, *Trifolium* sp.	20	60	60
Goosefoot, *Chenopodium album*	10	5	—
Field bindweed, *Strophocaulos* sp.	—	35	—

TABLE 2.—*Summary of trapping results. Parentheses indicate the number of grid-marked individuals captured in adjacent areas; T.N. = trap-nights*

SPECIES	LIVE TRAPPING				SNAP TRAPPING	
	Grid 7684 T.N.		Adjacent 1570 T.N.		Grid 510 T.N.	Adjacent 464 T.N.
	Ind.	Caps.	Ind.	Caps.	Caps.	Caps.
Blarina brevicauda	—	—	2	2	—	1
Sorex cinereus	—	—	—	—	—	2
Clethrionomys gapperi	—	—	—	—	—	1
Microtus pennsylvanicus	54	233	10(9)	15	1	9
Peromyscus maniculatus bairdi	39	225	10(9)	15	21	—
Peromyscus maniculatus gracilis	1	1	14(1)	39	—	3
Mus musculus	1	1	1	1	—	1
Citellus tridecemlineatus	3	18	1(1)	2	—	—
Zapus hudsonius	6	15	1	1	2	1

absent for a time. Maximum cover achieved by postdisturbance vegetation was 50 per cent on section 821, 75 per cent on 827 and less than 5 per cent on 910. The area of greatest predisturbance cover was section 910, while greatest postdisturbance cover was encountered on section 827.

Results of quadrat studies are summarized in Table 1. In addition to the alfalfa cover a number of other plant species were recorded. Utilization of some of these field plants as food by small mammals has been discussed in the literature by Bailey (1924), Hamilton (1940), Jameson (1947), Linduska (1950) and others.

RESULTS

The numerical results of live and snap trapping are given in Table 2. Nine species of small mammals were taken, the two predominant species being the meadow vole (*Microtus pennsylvanicus*) and the prairie deer mouse (*Peromyscus maniculatus bairdi*). One hundred twenty-six individuals of these two species were captured a total of 519 times. Since the other species obtained were not taken with sufficient frequency to permit population analysis, only the two primary species will be considered in the following discussion.

Predisturbance population.—During the predisturbance grid trapping, 51 *Microtus* were captured 227 times, and 27 *Peromyscus* were captured 155 times. Of the 51 *microtines*, 28 were males; and of the 27 deer mice, 17 were males. The greater number of males in each case undoubtedly reflects the greater wandering tendency of the sex as suggested by other investigators (Burt, 1940; Tanaka and Teramura, 1953).

The 51 *Microtus* were divisible into three age groups: 7 young, 10 subadults, and 24 adults. The age classes of 10 other voles could not be determined with certainty. Of the 27 *Peromyscus*, 2 were newborn young, 20 were subadults, and 5 were adults. The age composition of the two populations appears to indicate an expanding population of *Peromyscus* and a declining population of *Microtus*. Numerical trapping data, however, suggest the reverse; this apparent contradiction will be discussed in a later section.

Figure 2A indicates the range of predisturbance activity of *Microtus* on the grid. Trap density contours clearly indicate that the meadow voles were most active in the western (especially the northwestern) portion of the field, which was the area of greatest vegetative cover. Undoubtedly the voles were originally resident in this dense edge vegetation from whence they were moving onto the grid. This is substantiated by the fact that grid-marked meadow voles were captured on five occasions along the drainage ditch (Area 2). Such movements may have been associated with daily excursions from these border areas or they

may have represented a shift in residences. Daily trapping records indicated, however, that as the vegetation on the grid increased in height, more microtines were trapped there, and the captures occurred progressively farther from the edge areas.

Many microtine runways and burrows were found in the adjacent field borders. Their absence on the grid further indicates that the primary focus of the vole population was in these edge areas. Jameson (1947) found only poorly developed runway systems in alfalfa fields being utilized by prairie voles (*M. ochrogaster*). He explained this by the fact that in such fields immediate ground cover (tangled grass mats, mulch) is sparse and offers no mechanical obstacles to vole movement, thus alleviating the need for such runways. It appears, however, that in the present study the voles did not use the field as a primary habitat. Johnson (1926), in fact, noted that the favorite habitat of the prairie vole is uncultivated roadsides. In addition, Linduska (1950) reported that meadow voles were found more consistently in the sod borders adjoining croplands than in the fields themselves. He stated that such edge areas "might serve as a reservoir for the species and at times operate as foci for infestation of adjacent cropland."

Figure 2*B* shows the predisturbance activity of the prairie deer mouse. Two centers of activity are evident, one on the northern edge of the trapping grid and the other at the southern border. On the basis of the capture density at the southern edge of the grid, it appears that the region of greatest activity for this species was located in the center of the alfalfa field, actually south of the trapping grid, and that only a small portion of the deer mouse population was being sampled in the grid proper. A less intense center of activity was indicated in the northern edge of the field adjacent to the grassy fence row (Area 5). Since no predisturbance captures were obtained within this grassy fence row, the deer mouse activity appeared to be limited to the alfalfa field itself. As the grid vegetation increased in height, the number of grid captures of *Peromyscus* reached an early peak and then declined. This decrease in the number of captures may indicate a negative response of *Peromyscus* to the increasing density of vegetation, as will be discussed later.

Certain facts are evident from the results of predisturbance trapping: (1) The microtine population was located in the edge areas bordering the alfalfa field. Progressive increase in the utilization of the grid area paralleled a similar increase in vegetative height and cover. Individuals moving from edge areas onto the grid either remained there, which constituted a shift in habitat, or made repeated excursions from the edge for feeding and other activities. A preponderance of males was noted among the voles moving onto the grid; adults were more numerous than juveniles. (2) The deer mouse population, on the other hand, appeared to be located within the alfalfa field proper. As vegetation increased in height and cover, the frequency of captures progressively declined. As in the case of *Microtus*, males predominated in the captures. Unlike the *Microtus* population, however, juveniles were more abundant than adults. (3) For the predisturbance period, a zone of flux between *Microtus* edge dispersal and *Peromyscus* field activity is indicated.

Period of habitat disturbance.—The alfalfa was mowed to within 4 inches of the ground and remained on the ground to dry, affording considerable cover for several days. Rodent activity during this period before raking was obscured from direct observation and, as a result, immediate effects of the disturbance upon rodent activity could be ascertained only by reference to trapping data. Individual trapping records of several mice give some indication of movements from the trapping grid as a result of vegetative disturbance. For example, male *Microtus* No. 0030 had a predisturbance range of activity located primarily in section 910. After vegetative disturbance of this section, this vole was captured a considerable distance from its predisturbance trap-revealed range of activity. Similarly, male *Peromyscus* No. 5000 was found to be active almost exclusively in section 827 during the predisturbance period. After this section was cut, the mouse was trapped outside the grid in Area 5.

Direct evidence is lacking of any mortality which might have resulted from the farming operations, or of the fate of mice which may have remained during the cutting.

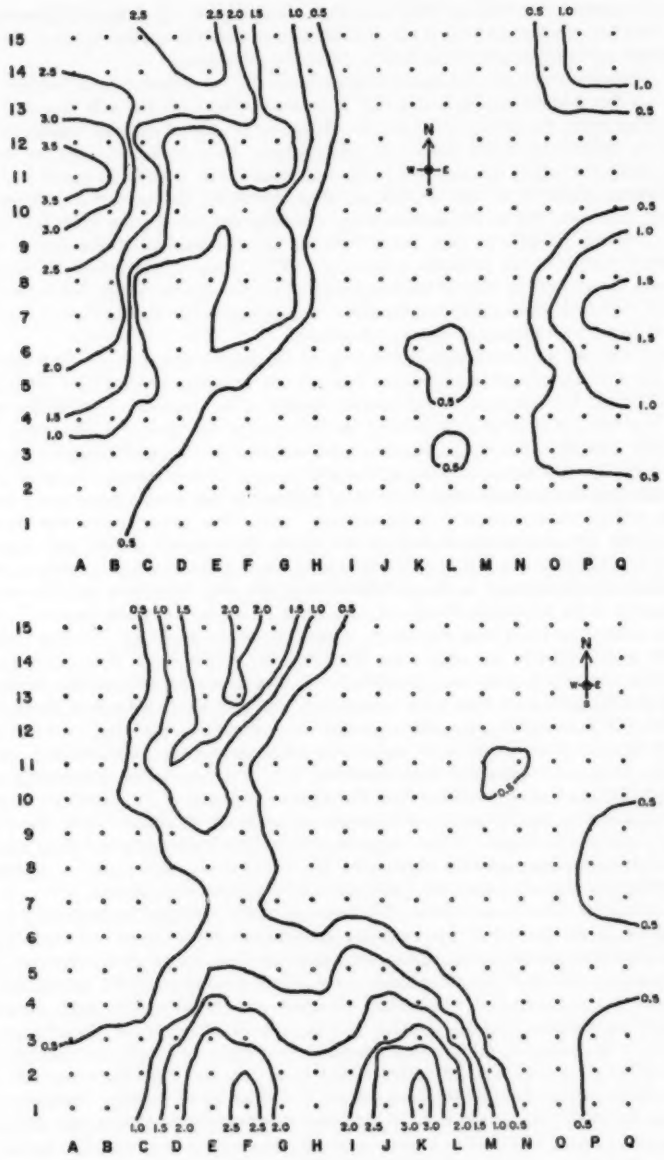

FIG. 2.—Legend opposite.

TABLE 3.—*Summary of numerical results of grid trapping throughout study period, given by section; only the two primary species are included*

	PREDISTURBANCE		POSTDISTURBANCE					
	Captures	New individuals	Captures			Individuals		
			live	snap	total	old	new	total
Section 821:*								
Microtus	47	12	1	1	2	0	2	2
Peromyscus	26	7	47	7	54	2	12	14
Section 827:†								
Microtus	65	20	5	0	5	1	2	3
Peromyscus	96	19	22	14	36	6	11	17
Section 910:‡								
Microtus	115	19	0	0	0	0	0	0
Peromyscus	33	1	1	0	1	1	0	1
Totals:								
Microtus	227	51	6	1	7	1	4	5
Peromyscus	155	27	70	21	91	9	23	32

* Sec. 821: Predisturbance—1800 live-trap-nights; postdisturbance—1080 live-trap-nights, 180 snap-trap-nights.

† Sec. 827: Predisturbance—2622 live-trap-nights; postdisturbance—798 live-trap-nights, 240 snap-trap-nights.

‡ Sec. 910: Predisturbance—1180 live-trap-nights; postdisturbance—204 live-trap-nights, 90 snap-trap-nights.

Postdisturbance populations.—Following reestablishment of the trapping grid successively upon sections 821, 827 and 910, only a few microtines were captured. These included for the three areas, respectively, 1, 5 and 0 in the live traps and 1, 0 and 0 in the snap traps, or a total of seven *Microtus* captures. Deer mice, on the other hand, were abundant following the disturbance. These included 47, 22 and 1 in the live traps and 7, 14 and 0 in the snap traps, or a total of 91 postdisturbance captures of this species.

The seven *Microtus* captures included five individuals, four of which were new. The 91 *Peromyscus* captures represent 32 individuals, 23 of which were new. Thus for each species 75–80 per cent were taken for the first time in the postdisturbance period, pointing to the fact that new individuals were moving onto the grid from other areas following the farming activities. Depopulation of the grid area may have resulted from mowing or baling casualties, forced emigration of predisturbance residents, increased exposure to predation, or a combination of these factors. Following disturbance, the "edge effect" of microtine activity was essentially eliminated. The postdisturbance trapping periods on section 821 and 827 were certainly long enough to reveal some microtine activity if it had occurred.

Comparison of pre- and postdisturbance populations.—Pre- and postdisturbance trapping data for the three sections are summarized in Fig. 3 (*A, B, C*) and in Table 3. Pre- and postdisturbance rates of capture upon the three grid areas may be compared. For *Microtus*, these include the following: 821 (0.026 per trap-night, predisturbance to 0.001, post-

FIG. 2.—The trap-revealed range of predisturbance activity on the trapping grid. Contour lines indicate the density of captures per trap based upon data smoothed as follows: the number of captures per trap for a given trapping station is doubled and added to the raw values of the eight adjacent surrounding stations, the total then being divided by ten. Above, *Microtus pennsylvanicus*; below, *Peromyscus maniculatus*.

disturbance), 827 (0.024 to 0.005), and 910 (0.097 to 0.00). These results indicate a substantial decline in the rate of capture of *Microtus* upon each of the grid areas.

For *Peromyscus* the rates of capture include the following: 821 (0.014 to 0.043), 827

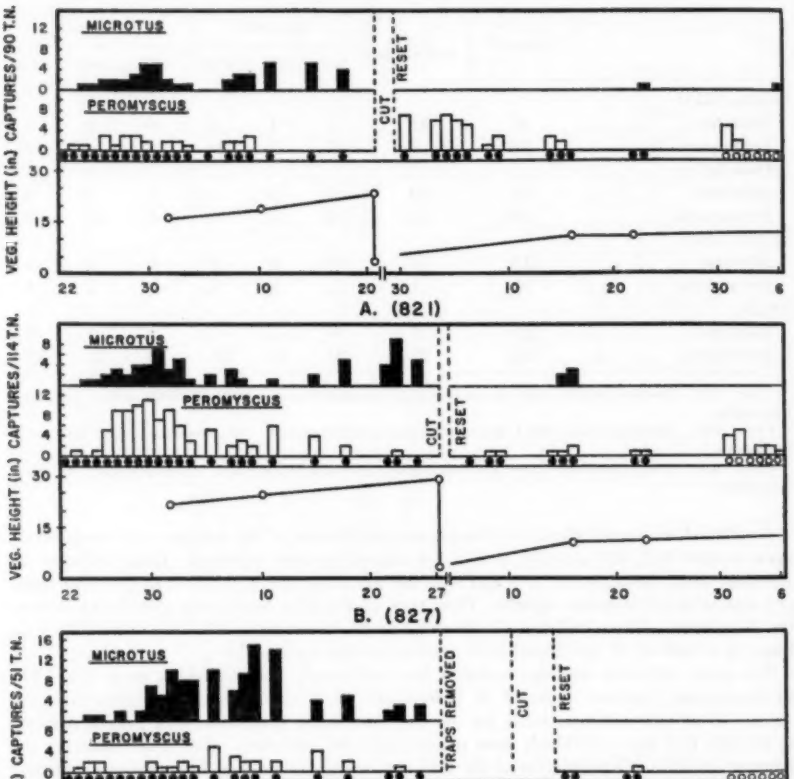

FIG. 3.—Summary, by section, of the results of trapping on the grid throughout the study period. Black circles indicate periods of live trapping; white circles indicate periods of snap trapping. Also shown is the height of grid vegetation. *A*, Section 821—live captures per 90 trap-nights, snap-captures per 30 trap-nights; *B*, Section 827—live-captures per 114 trap-nights, snap-captures per 40 trap-nights; *C*, Section 910—live-captures per 51 trap-nights, snap-captures per 15 trap-nights.

(0.035 to 0.025), and 910 (0.027 to 0.005). Thus, the rate of capture of the deer mice on 821 was trebled, on 827 it showed a slight decline, and on 910 (trapped only briefly in the postdisturbance period) there was a considerable reduction.

Considering the entire study period, 227 predisturbance and 7 postdisturbance captures of *Microtus* were obtained (32.4 : 1.0 ratio). For *Peromyscus*, 155 predisturbance captures were made compared with 91 postdisturbance captures (1.7 : 1.0 ratio). The *Microtus* captures represented 51 individuals in the predisturbance and only 5 in the postdisturbance period (10.2 : 1.0 ratio). For *Peromyscus*, 27 predisturbance and 32 postdisturbance individuals were taken (0.8 : 1.0 ratio). Hence, most of the meadow voles were taken prior to vegetative disturbance, whereas deer mice were obtained consistently before and after the cutting. This appears to reflect a different response to the habitat disturbance by each of the two species.

Predisturbance sex ratios for both species were heavily in favor of males. Postdisturbance trapping data, however, indicated an opposite tendency (for *Microtus*, 2 males to 2 females, 1 newborn young; for *Peromyscus*, 11 males to 16 females, 5 newborn young). Although based upon small numbers, these data may indicate either abnormal population movements or differential mortality among the sexes associated with the farming activities.

To obtain a picture of the total grid populations throughout the entire study, composite live-trap data are expressed in Fig. 4 in terms of 255 trap-nights (this unavoidably overemphasizes the postdisturbance data obtained on section 821). It appears that, in general, density of the *Microtus* population is positively correlated with vegetative height and cover, whereas density of the *Peromyscus* population appears to be negatively correlated with these factors. Data from snap trapping reinforce the above interpretation by indicating that postdisturbance grid inhabitants included a sizable population of *Peromyscus* (22 individuals)

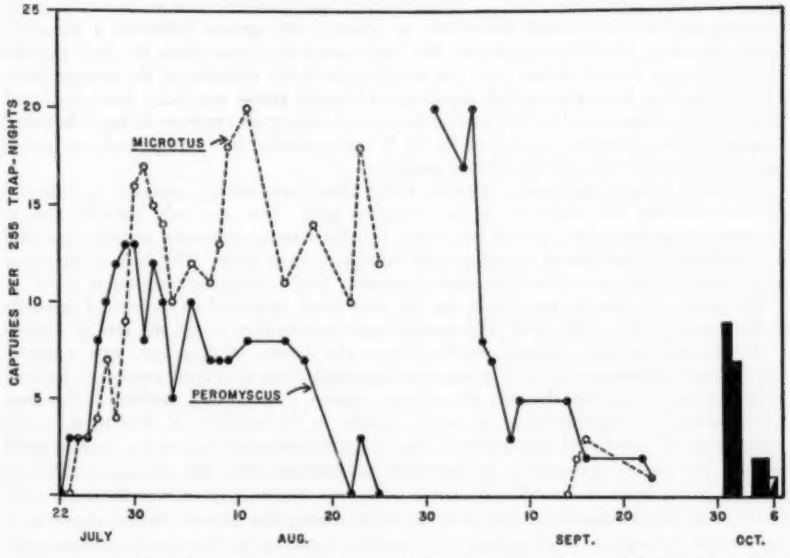

FIG. 4.—Results of trapping on the entire grid throughout the period of study. Live-trapping data during the disturbance period are adjusted to 255 trap-nights. Snap-trapping data are given in bar diagram and are based on captures per 85 trap-nights.

and only a single *Microtus*. Postdisturbance live trapping (6 individuals) and snap trapping (9 individuals) in adjacent areas (especially northern and western edges) revealed a population of *Microtus* resident in the edge areas even though these voles *did not* reinvade the grid. Postdisturbance captures were mostly of new individuals, leaving open the question of the fate of the earlier grid-marked microtines.

DISCUSSION

This investigation was designed to determine the effects of destruction of cover vegetation on small mammal populations. The study area offered an opportunity to analyze the ecology of two closely associated habitat types, viz., croplands and adjoining brushy edge areas.

Trapping data established the center of meadow vole activity in the marginal areas. As the alfalfa increased in height and cover during the precutting period, *Microtus* were found to be moving farther out into the field. The lack of characteristic runways in the field suggested that these movements were temporary feeding excursions. The increase in individuals captured and the extent of advance toward the center of the trapping grid, however, provided circumstantial evidence that these voles may have been shifting residences. Hence, had the predisturbance period been of longer duration, vole runways and burrows may have appeared on the field.

Age composition of the predisturbance *Microtus* population indicated a preponderance of adults, typical of a declining population. The numerical data, however, indicated an expanding population, and it appears that the shift in ranges of *Microtus* was accomplished primarily by adult males and to a lesser extent by adult females, although apparently not by young individuals. Since young are as trapable as adults (Hamilton, 1941; Gunderson, 1950) the grid portion of the population should reflect, in large measure, the age composition of the total population. Hence, the number of juveniles must actually have been low in the total population. Such a condition may have resulted from unsuccessful spring breeding or from differential destruction of younger age groups following a successful spring breeding. Definite support for the latter possibility stems from the fact that the alfalfa field was mowed in late June, one month prior to the initiation of the present study. During this first harvesting a high percentage of spring young may have been destroyed. This is further borne out by the fact that the second cutting also appears to have destroyed numbers of the microtines (only 3 of the 51 *Microtus* marked in the predisturbance period were recaptured in the postdisturbance period).

Following habitat disturbance, *Microtus* "edge effect" was sharply curtailed as indicated by the relatively few captures on the disturbed grid. This was only partially due to mortality of previous grid inhabitants, since postdisturbance edge-area trapping revealed a considerable population of microtines still inhabiting these areas. The lack of reinvasion of the grid by this species must be related primarily to the absence of vegetative cover.

The prairie deer mouse population, on the other hand, appeared to be located primarily in the center of the alfalfa field, and as vegetation increased in height the rate of capture of *Peromyscus* declined. During predisturbance, the density of deer mice was relatively low (5.7 individuals per acre). The numerical preponderance of juveniles seems to indicate an expanding population although the rate of capture progressively declined. This may reflect increasing trap-shyness or an actual decline in the numbers of deer mice on the grid during the predisturbance period. Progressive trap-shyness cannot be entirely ruled out, but this factor appeared to be relatively insignificant since the average number of captures per individual was 4.5 and several mice were captured more than 20 times each. There is no direct evidence of increased mortality during this period. Hence, decrease in captures of *Peromyscus* is interpreted as a negative response by this species to increasing density of the grid vegetation. It is possible that during predisturbance the deer mice were retreating to areas (in the alfalfa field or elsewhere) of less dense vegetative cover.

During the precutting period, a zone of population flux between these two species was

indicated, and with increase in vegetative height there resulted an encroachment of microtines upon previously established deer mouse habitat. From what is known of the food habits of these two species (Hamilton, 1940; Linduska, 1950) it is unlikely that population stress based upon competition or intolerance actually existed between the vole and deer mouse populations utilizing the field. Furthermore, meadow voles are diurnal (Hamilton, 1937) whereas deer mice are primarily nocturnal (Johnson, 1926), and the two species are known to occupy associated habitats over much of their distributional ranges. Hence the changes in predisturbance populations are interpreted primarily as responses to changes in the vegetation rather than to coactions between the two rodent species.

During the period of habitat disturbance no direct evidence was obtained regarding mortality resulting from the disturbance or the fate of individuals remaining on the study area during this time. Trapping results in the period following disturbance, however, revealed that several individuals had moved considerable distances from their predisturbance ranges of activity, possibly forced from the grid due to the farming activities. Some of the numerical decrease noted in the postdisturbance *Microtus* population may have been the result of increased predation by hawks and owls. This is of common occurrence in recently harvested hay fields in the West (Miller, *in litt.*).

The preponderance of new individuals captured during the postdisturbance period indicates unusual population movements. These new individuals may have been forced to move from other portions of the alfalfa field, or they may have come from outside the area in response to a "biological vacuum" resulting from vegetative disturbance (cf. Calhoun and Webb, 1953). The postdisturbance sex ratio in favor of females was a reversal of that obtained in the predisturbance period and may indicate abnormal population movements or differential sex mortality due to farming activities. Postdisturbance grid captures consisted almost entirely of deer mice, meadow voles being rare on the cut field. These observations substantiate the conclusion that, within the range of conditions investigated, *Microtus* responds positively to vegetative height and cover, whereas *Peromyscus* responds negatively.

These results may be explained by the fact that *Microtus* is diurnal and *Peromyscus* is largely nocturnal. The diurnal activity pattern of *Microtus* may require a dense vegetative cover as protection against predators or extreme physical conditions. Conversely, the fact that *Peromyscus* is nocturnal indicates that it may be able to move more freely in open areas without benefit of cover. The results of the present study suggest not only that cover is unnecessary for *Peromyscus*, but that its absence is preferable. This situation is somewhat comparable to that indicated by Miller (1955), who studied two different species of small rodents.

These results are substantiated by observations of other workers. Eadie (1953) correlated vegetative cover and the differential utilization of a timothy hayfield by meadow voles. Likewise, Martin (1956), in his study of the closely related prairie vole (*Microtus ochrogaster*), cited many instances of the critical role of vegetative cover in the distributional pattern of this species. On the other hand, Linduska (1950) and Verts (1957) have found that sparseness of ground cover was not a limiting factor in the distribution of deer mice.

Certain general relations of these small mammal populations to the vegetative cover may be postulated. In croplands which are bordered by brushy vegetation, dispersal of microtines from their edge area habitat is a function of the vegetative height and cover on the adjoining cropfield. In fields which undergo considerable summer disturbances (e.g., alfalfa fields) voles are unable to establish permanent residence during the farming season, being essentially restricted to the edge area. In farm fields which remain undisturbed for long periods (enabling extended summer growth of vegetation) meadow voles undoubtedly do establish field residence.

Peromyscus, on the other hand, prefers less dense vegetative cover than does *Microtus*. The former somehow responds favorably to reduction of habitat vegetation and, apparently, in regularly farmed areas maintains its primacy of residence in these disturbed fields.

SUMMARY

An investigation was carried out to determine the effect of habitat disturbance (as produced by farming activities) upon a small mammal population. The study area included two closely associated habitat types, a cropfield (alfalfa) and adjacent edge areas. Predominant species obtained were the meadow vole (*Microtus pennsylvanicus*) and the prairie deer mouse (*Peromyscus maniculatus bairdi*). Primary habitat of *Microtus* was the edge areas, whereas *Peromyscus* was found in the cropland proper. As vegetation increased in height and cover during the predisturbance period, *Microtus* showed increased utilization of the field while *Peromyscus* made an opposite response. Following cutting, trapping data from the disturbed area indicated a negative response of *Microtus* and a positive response of *Peromyscus* to the sparse vegetative cover. This differential behavior to conditions of vegetative cover has been explained in part by reference to the activity patterns of these two species. In addition, postdisturbance trapping data also revealed changes in the sex ratio and in influx of a high percentage of new individuals upon the disturbed area giving evidence of unusual population movements resulting from the farming activities.

ACKNOWLEDGMENTS

Thanks are due to Ralph L. Dix for the identification of plants and to Walter Pelzer for identification of the small mammals. Thanks are also due to Miss Ellen J. Ryan for preparation of the illustrations and to Anthony LoBue for final typing of the manuscript. Finally, a debt of gratitude is owed to Mr. and Mrs. Erwin Frank, of Cederburg, Wisconsin, for the many courtesies and facilities rendered during the course of the present study.

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Dept. of Biology, Marquette Univ., Milwaukee 3, Wisconsin. Received January 2, 1958.

GENERAL NOTES

AN UNUSUAL CONCENTRATION OF *SOREX CINEREUS*

On April 23, 1955, at Island Beach State Park, Ocean County, New Jersey, I witnessed a local concentration of masked shrews, *Sorex cinereus*. Other workers have recorded high populations of shrews as indicated by trapping data. De Vos (Jour. Mamm., 38: 256–258, 1957) noted a peak population of *S. cinereus* which was of widespread nature in northern Ontario during the late summer of 1955. Fowle and Edwards (Jour. Mamm., 36: 36–41, 1955), in analyzing captures of *Blarina brevicauda* from Algonquin Park, Ontario, found the species four times more abundant during the summer of 1947 than in the other five summers between 1945 and 1950 combined. The present data suggest a higher concentration of a North American shrew than has previously been recorded.

The observation was made between 8:00 and 9:00 AM while a dense fog blanketed Island Beach peninsula. Attention was first drawn to the shrews by rustling in the ground litter and high pitched twittering squeaks. The shrews appeared to be generally active throughout a 100 × 5 yard strip of mixed catbriar (*Smilax* sp.) and grasses, which paralleled an abandoned dirt road. The plot was bordered by a mixed hardwood and pine woodland. At one place in this strip the roof from a dismantled shed covered a portion of the ground. Several shrews were observed by dislodging shingles and peering in under the roof. An estimated 20 individuals were seen running about in an area of approximately 25 square yards at this site. Judging from the noise, the animals were no more concentrated here than elsewhere in the strip. I set several snap traps and immediately caught two males and a female. These specimens, which are in the collections at the Museum of Natural History, University of Kansas (K.U. 68583–68585) are adults as determined by the condition of the teeth. The uterine horns of the female measured 3.0 mm. in diameter, indicating the individual was sexually active. Jameson (Jour. Mamm., 36: 344, 1955) considered female *S. trowbridgei* to be fecund or in the early stages of pregnancy when the uterine horns were 2.0 mm. or more in width. Unfortunately, the condition of the testes of the males was not recorded.

I returned to the area at sunset but heard no shrews. Furthermore, a line of 50 snap traps baited with peanut butter and oatmeal caught no mammals during the night of April 23–24. The shrews may have congregated in an area for some unknown reason and then departed. Their behavior did not suggest any mass movement, however, and no environmental disturbances that might have precipitated such a movement were noted in the vicinity. On the other hand, the population may have been present in the area during the night, but the shrews were neither attracted to the bait nor as active as they had been during the morning of April 23.—GLEN E. WOOLFENDEN, *Dept. of Biology, Univ. of Florida, Gainesville. Received April 1, 1958.*

AN ALBINO *SOREX VAGRANS*

Albinism in the genus *Sorex* is rare. Jackson (N. Amer. Fauna 51, 1928), who examined more than 10,000 specimens of this genus, recorded three instances of albinism, only one of which was complete. This one case of complete albinism is in a specimen presumed to be *Sorex tundrensis*. Allen (Jour. Mamm., 16: 223, 1935) reported a completely albino *Sorex cinereus* from Seba Beach, Alberta. Pearce (Jour. Mamm., 15: 67, 1934) recorded an instance of partial albinism in a specimen of the same species from near Marcellus, New York. Albinism does not seem to have been recorded in the *Sorex vagrans* group, and Findley (Univ. Kansas Publ., Mus. Nat. Hist., 9: 1–68, 1955), who examined almost 3,500 specimens, made no mention of the occurrence of albinos.

A specimen of *Sorex vagrans* from 3 miles south of the Montana boundary at Mount Jefferson, 7,000 feet, Fremont County, Idaho, is totally white. This individual (AMNH 120747), a first-year female, was collected by R. M. Gilmore on August 6, 1935, by a spruce log in dense thicket. The hairs of this specimen are white to the base and there are no colored hairs present. The color of the eyes was not recorded.

This specimen is tentatively assigned to *Sorex vagrans vagrans*, although Findley (*ibid.*) does not show this subspecies as occurring in northeastern Idaho. The external measurements—110, 45 and 13 mm.—recorded for this specimen are larger than the averages given by Findley for eight topotypes of *S. v. vagrans* and are closer to the average measurements of nine topotypes of *S. v. obscurus*. In cranial measurements, this albino shrew measures: condylobasal length, 16.1; palatal length, 6.4; maxillary tooth-row, 6.0; cranial breadth, 8.1; least interorbital breadth, 3.3; maxillary breadth, 4.9 mm. All of these measurements are within the range of *vagrans* but are smaller than those recorded for *S. v. obscurus*, except for the interorbital breadth, which is larger than any *vagrans* listed by Findley. This specimen may be an intergrade between *vagrans* and *obscurus*.—Richard G. Van Gelder, *American Museum of Natural History, New York 24, N.Y.* *Received April 29, 1958.*

SOREX LONGIROSTRIS IN EASTERN ALABAMA

Sorex longirostris was listed as a rare shrew in Alabama by Howell (N. Amer. Fauna 45, p. 22, 1921) and according to our present knowledge is still in that category, although we know much more about its occurrence and habitat preference at the present time. Since the one specimen reported by Howell was taken near Autaugaville, five additional specimens have been taken, to the writer's knowledge. Following are their data:

No. 1–1, collected November 12, 1950 near Auburn, Lee County, was a young adult female weighing 4.3 grams. Total length was 84, tail 31 and hind foot 10 mm. (Dusi, Jour. Mamm., 32: 2, 1951).

No. 1–2, collected February 16, 1954 near Clayton, Barbour County, was an immature male weighing 2.9 grams. Total length was 82, tail 29 and hind foot 9.5 mm.

No. 1–3 was taken November 10, 1954 from a barn owl pellet (Dusi, Alabama Birdlife, 5: 7, 1957) at Auburn, Lee County. Only the two dentary bones were recovered. They were comparable in length with the dentaries of the other shrews and the teeth were not worn, so the animal was probably a young adult.

No. 1–4 was taken February 1, 1955 near Auburn, Lee County, and weighed 2.8 grams. Total length was 78, tail 30 and hind foot 10.5 mm. It was a young adult, sex undetermined. No. 1–27 was taken at the same place on April 18, 1959. It contained four 8.5-mm. embryos. Measurements were 70.5, 26, 11 mm., and 4.6 grams.

Nos. 1–1 and 1–2 were found dead. Number 1–3 was taken from a barn owl pellet and No. 1–4 was the only specimen trapped. Evidently the species is both rare and hard to trap.

Howell's report (op. cit.) of the first Alabama specimen implied that he considered a swampy habitat desirable for this shrew. The five specimens of the writer were taken from an upland old field community with *Cryptotis parva*, *Blarina brevicauda*, *Scalopus aquaticus*, *Sigmodon hispidus*, *Pitymys pinetorum*, *Peromyscus polionotus* and *Mus muscu-*

lus. All of the specimens, except that from the owl pellet, were taken some distance from water.

The specimens taken at Auburn were from the Piedmont. The specimen from Clayton was well into the Upper Coastal Plain, since Auburn is on the fall line and Clayton is about 45 miles to the south. These distribution data fall within the geographic range map of Jackson (N. Amer. Fauna 51, p. 84, 1928). Sufficient field work has not been done throughout the state to make this absolute. The rareness of the species and the difficulty of trapping it necessitate much more careful work before its distribution can be accurately determined.—JULIAN L. DUSI, *Dept. of Zoology–Entomology, Alabama Polytechnic Institute, Auburn.* *Received March 10, 1958.*

ATTEMPTED "CANNIBALISM" AMONG CAPTIVE VAMPIRE BATS

It seems well established that a few species of bats of carnivorous habit will, when opportunity affords, kill and consume individuals of other, smaller species of bats, in addition to a varied fare of small rodents, birds, reptiles, amphibians and larger insects. Such behavior has repeatedly been observed under natural conditions in respect to the false vampire, *Lyroderma* (= *Megaderma*) *lyra lyra* of India (cf. G. M. Allen: Bats. Harvard Univ. Press, 1940). Similar cannibalistic propensities have been described by Dunn (Jour. Mamm., 14: 188–199, 1933) in a captive specimen of the large leaf-nosed bat, *Phyllostomus hastatus*, in Panama, which readily killed and ate specimens of several species of smaller bats introduced into its cage, along with sundry mice, bits of meat, bananas, etc. It may be presumed that smaller bats are at least occasionally taken by this species in nature. Carnivorous, and hence potentially cannibalistic, species of bats are relatively few, but thus far among these there is no evidence that they prey upon members of their own species. This does not exclude the possibility that they might do so under stress of acute hunger, such as might be artificially induced in caged animals, but this experiment has not yet been attempted.

In a very real sense the vampire bat, which feeds upon the blood of mammals and birds, is carnivorous, even though its attacks seldom kill its victims. It is conceivable that vampires might attack other bats in nature, but I know of no evidence that this occurs, the usual prey seeming to consist of fowls and larger mammals. It is of interest, therefore, that a presumed case of "cannibalism" developed in a captive colony of *Desmodus rotundus* maintained in this laboratory for experimental purposes. The animals were collected in Morelos State, Mexico, in September 1957. They were subsequently confined in four semi-darkened cages (20 × 20 × 20 inches), 15 to 20 bats per cage, where they quickly adapted to taking defibrinated blood from a finger bowl placed on the cage floor. It was soon noted that the occupants of one of the cages, which contained a few more bats than the other three, consistently consumed all of the blood introduced each evening, whereas some was usually left over in the other cages. Since the number of bats in this cage was only slightly greater than in the other three, and they seemed to be getting on well, it was assumed they were receiving sufficient blood and the ration was not increased.

After several weeks it was noted that all of the bats in this cage began to display what appeared in the semi-darkness of the cage interior to be a fading of the fur of the shoulders, interscapular region and back of the head. A similar change did not occur in the bats of the other three cages. During the ensuing two weeks the condition worsened to such an extent that the bats were removed for closer inspection. It was immediately determined that the apparent fading was owing to a variable loss of hair from the affected regions, exposing the bare skin beneath. Most significantly, nearly all of the specimens displayed in the depilated areas signs of small lacerations, some healing, others relatively fresh, but all obviously consisting of bite wounds. It can probably be assumed that vampires (and other bats) occasionally bite one another in fighting, or in circumstances conducive to excitement or nervousness, but the frequency and persistence of biting in this group, contrasted with its absence among the bats in the adjoining cages maintained under similar

conditions, suggested that the behavior here was neither casual nor incidental. Under the circumstances it was immediately suspected that the members of this group of bats, which alone consistently exhausted its daily blood allotment, might be attempting to compensate for a *chronically* deficient food supply by parasitizing one another. Accordingly, the daily ration of blood was increased to the point where this group also consistently failed to consume all of the blood provided. During the ensuing weeks the condition of the depilated areas began to improve; within six weeks the hair coat was virtually restored in all specimens, and evidence of biting among these bats had disappeared.

It is not without interest that despite the multiple lacerations sustained by most of the animals, none of them died during the period. This indicates that extensive loss of blood did not occur, and that the attempted parasitism was probably not highly successful—for a vampire can consume at a feeding far more blood than is contained in its own circulation. Furthermore, it is doubtful that a vampire, which is noted for its alertness, would allow itself to be fed upon by another of its kind without offering resistance or attempting to escape. The virtual restriction of bites to the shoulder region and back of the head is probably accounted for by the fact that the animals typically cling in a tight cluster in the angle between the top and back wall of the cage, and in this position only these regions are exposed to the bites of neighboring animals.

While other interpretations might conceivably be placed upon the exaggerated biting behavior of this group of bats, the simplest explanation consistent with the observed facts is that it represented a purposive and cannibalistic attempt to secure blood in the face of a *chronically* deficient food supply. When blood was subsequently supplied in adequate amounts this aberrant behavior ceased, and the injured animals recovered.—WILLIAM A. WIMSATT, *Laboratory of Histology and Embryology, Dept. of Zoology, Cornell Univ., Ithaca, N.Y.* *Received March 28, 1958.*

[Work with bats in this laboratory is supported by research grants (G-2188, G-7474) from the National Science Foundation.]

SWIMMING BEHAVIOR OF BATS

It has been well established in the literature that bats of many species are capable of swimming. Reports are based upon animals that have been knocked or have fallen into the water and also on animals that have been placed experimentally in the water (Ryberg, Studies on bats and bat parasites, 1947) and others. Ryberg devoted a chapter to swimming by bats.

It has not been established, however, that bats will enter the water voluntarily. I have been able to locate only one reference to the voluntary swimming of bats, and this report would seem to deserve corroboration before acceptance. Ryberg (*op. cit.*), quoting Trouessart (Ann. Sci. Nat. Zool. Paris, 8: art. 12; 24 pp., 1879) stated that "Forster, who in the capacity of naturalist accompanied James Cook on his second circumnavigation of the globe 1772 to 1775, is supposed to have observed some Megachiroptera bathing and swimming. The observation was made in the Tonga archipelago for which reason the report, if correct, must presumably concern the only species occurring there, *Pteropus tonganus* Quoy et Garmard 1830."

The voluntary entering of the water by several individuals of *Myotis velifer incautus* (J. A. Allen) was observed on December 11, 1952 and February 24, 1953 at Double Entrance "S" Cave, Comanche County, Kansas, while I was engaged in ecological studies of the hibernating colony of *Myotis velifer* which was occupying that cavern (Ecology, 36: 706–732, 1956). Although the conditions here described are not the most natural, I believe that the observations are significant.

A procedure that was utilized in the study of movements of hibernating individuals involved the collecting of bats from clusters; the bats were placed in cotton sacks, 50 to 100 bats per sack, and were removed from the cavern at which time they were weighed,

sexed, checked for tooth wear and banded. They were then released one by one and each bat's flight behavior was noted as it found the entrance to the cavern by itself.

On the two occasions when swimming was observed, however, the bats had been allowed to remain packed in the sacks for so long that, although their rectal temperatures (34 to 38°C.) indicated they were warm enough to fly, most were only able to move their wings slightly, not sufficient for flight. They were capable of rapid crawling, however. Apparently the crowded conditions in the sacks did not allow for adequate circulation in the wings. I have noted on many occasions that bats awakening from hibernation stretch their wings and dress them with the teeth and tongue before flying from the hibernating cluster.

The bats that were unable to fly were placed near the entrance of the cavern and released on the ground. A shallow pool of water approximately 8 feet in diameter lay between the released bat and the cavern entrance. In practically every instance, the bat crawled directly toward the cavern entrance until it reached the pool of water. At this point, it stopped, lapped water for many seconds, and then crawled into the water and swam directly to the cavern entrance, using the peculiar swimming motion of half-extended wings flapping in unison against the water surface. Upon reaching the other side of the pool, it was soaking wet and crawled up the gypsum rock at the outside entrance of the cavern to a height of 6 to 8 feet. Here, in good light, each bat dressed its wings and within 10 minutes flew into the cavern where it joined a hibernating cluster.

It is perhaps significant that another cavern lay directly behind the place where the bats were released; to reach it, it was necessary to crawl a shorter distance and cross no water. This cavern did not contain *Myotis*, however, whereas the cavern toward which they did crawl and swim contained over 5,000 individuals, many of which had been awakened in the course of the day's study. The fact that all of the bats moved toward the occupied cavern may be due to many factors, although one factor indicated by experimentation is that bats near a cavern entrance may find that entrance through sounds made by active bats within the cavern (Twente, Jour. Mamm. 36: 379–390, 1955).

It may be concluded that, at least under the dire circumstances of capture and release, *Myotis velifer incautus* will readily enter the water and swim.—John W. Twente, *Dept. of Zoology, Univ. of Utah, Salt Lake City.* *Received March 15, 1958.*

NOTES ON THE YUMA MYOTIS IN NEW MEXICO

There have been few observations on *Myotis yumanensis* in New Mexico, especially with regard to breeding habits. Mumford (Jour. Mamm., 38: 260, 1957) collected eight *yumanensis*, each containing a single embryo, on the Bosque del Apache National Wildlife Refuge near San Antonio, New Mexico, but this is apparently the extent of recorded breeding observations. During the summer of 1957, while working at this same refuge, I had the opportunity to make further observations on a colony of this species living in one of the refuge storage buildings.

On June 6 five females were collected and prepared as study skins (Univ. Ariz. No. 5615–5619). Of these, four contained a single embryo each, while the fifth had none. They measured 13, 13, 14, and 16 mm. respectively in crown-rump length. On June 15, thirty individuals, all females and apparently gravid, were captured and banded. There were no young bats present at this time. Examination of the colony on June 25 also failed to reveal any young. Four days later, however, a dead juvenile was found beneath the colony. At this time, four of eight females captured in flight within the building had single young clinging to their ventral surfaces. Five juvenile males were captured on July 18 in a garage approximately ¼ mile from the main colony. These were the first males collected and indicated that some of the young were living independently at this time.

During observations, an example of a habitual activity pattern was noticed in one adult female. This individual was captured at 9:00 PM on August 23 while it was hanging from a porch rafter. It was banded and twice recovered from the same spot at the same time on August 25 and 27. This roost was a temporary resting place, since the bat was never

observed there at other times, although periodic checks were made. It seems probable that some species of *Myotis* utilize a very definite hunting area, as this observation and others (Hough, Jour. Mamm., 38: 121–122, 1957) tend to indicate.—Larry R. Commissaris, *Dept. of Zoology, Univ. of Arizona, Tucson. Received May 2, 1958.*

THE HOARY BAT IN THE PANHANDLE OF TEXAS

A hoary bat, *Lasiurus cinereus cinereus*, was collected at Gruver, Hansford County, on September 19, 1954. This bat, a fat adult male, was "rescued" from a house cat. Another hoary bat was obtained by C. E. Wright 10 miles northeast of Wayside, Armstrong County. This bat was found in a small cave in the company of *Myotis velifer incautus* and *Corynorhinus rafinesquii pallescens*. Eads *et al.* (Jour. Mamm., 38: 514, 1957) record a hoary bat from Lubbock, 200 miles south of Gruver. These three records of occurrence indicate that this species may be widespread throughout the Panhandle.—William L. Cutter, *Gruver, Texas. Received May 17, 1958.*

PTERONOTUS DAVYI IN NORTHWESTERN MEXICO

Previous northernmost records for *Pteronotus davyi fulvus* (Thomas) in Western Mexico are within the states of Colima and Jalisco (Davis and Russell, Jour. Mamm., 33: 234–239, 1952). Therefore, recent collections of this species by D. B. Adams and the writer in Sinaloa and Sonora are of interest.

On November 12, 1957, a cave, approximately 15 mi. SE Carbo, Sonora, was investigated. The cave contained an estimated 200 *Tadarida brasiliensis mexicana* (Saussure), 400 *Macrotus*, and several thousand *Natalus*, *Mormoops* and *Pteronotus*. One male *Pteronotus davyi fulvus* was preserved as a skin.

On November 14, 1957, we investigated a cave at Monte Largo, approximately 14 mi. W Pericos, Sinaloa. The cave contained an estimated 200,000 *Tadarida b. mexicana*, 800 *Pteronotus*, and a few *Chilonycteris rubiginosa* and *Myotis velifer*. Three male *Pteronotus davyi fulvus* were preserved.—Denny G. Constantine, *U. S. Public Health Service, Communicable Disease Center, Atlanta, Georgia. Received April 28, 1958.*

EARLY BREEDING OF THE BLACK-TAILED JACK RABBIT IN SOUTHEASTERN COLORADO

During the course of collecting black-tailed jack rabbits, *Lepus californicus*, in February, March and April of 1958 in southeastern Colorado, casual autopsies of specimens taken indicated a much earlier breeding pattern than has heretofore been recorded in Colorado. Although the animals had specifically been collected for parasitological examination, the reproductive condition of each individual was also noted.

On February 22, a female killed 35 miles east of Colorado Springs in semi-arid prairie country contained a half-term embryo. The next day, another female containing an embryo was collected 120 miles east of Colorado Springs in similar country. On March 1 and 8, rabbits were taken in an area 35 miles east of Colorado Springs. Three of the females were gravid and all males collected here had descended testes. Hunting was discontinued for 23 days but was resumed for three days beginning April 1. Seventy rabbits were taken during these three days. The 29 females were killed and examined. Every one was pregnant, with embryos ranging up to full term in development.

Weather conditions for the months of January and February, 1958, were unusually mild for winter. Over a 32-year period the mean January temperature for Calhan, a station representative of the country in which these rabbits were taken, was 26.9°F. The mean temperature for January, 1958, was 32.6°, or 5.7° above the January normal. In addition, usual precipitation for January here is .32 inches, whereas the total precipitation for January, 1958, was .09 inches.

These weather records support the idea put forth by several mammalogists that temperature and precipitation in optimal combination may produce conditions conducive to an earlier or later breeding season than is usual. In Kansas, Brown (Ecology, 26: 308–309, 1945) collected white-footed mice in breeding condition throughout the winter of 1944–45, a period characterized by above-normal temperatures and below-normal precipitation. In the fall of 1952, Beidleman (Jour. Mamm., 35: 118, 1954) collected a number of breeding harvest mice and white-footed mice up to the end of October in northern Colorado. This was the driest fall on record in the region and was further characterized by above-average temperatures, a minimum of cloud cover, and very little wind, conditions similar to those of January and February of 1958. Two years later, Reed (Jour. Mamm., 36: 462–463, 1955) collected reproductively active white-footed mice in January in northern Colorado, again during a period characterized by above-average temperatures and below-average precipitation.

Although it is not unusual to collect breeding jack rabbits in the Central Valley of California during the winter, the earliest collection date from Colorado for a gravid female black-tailed jack rabbit was formerly reported in print by Burnett as April 29 (Colo. State Ent. Office Circ. 52: 3–18, 1926). The normal breeding season extends from May into September. Our findings in Colorado in 1958 include gravid females taken as early as February 22 and from that date on into the spring. Of the 99 rabbits killed, 34 were pregnant females and a number were males in breeding condition. These figures emphasize an earlier than usual breeding season for the black-tailed jack rabbit in Colorado in 1958, occasioned probably by the above-normal temperatures and below-normal precipitation.—Gerald W. Esch, Richard G. Beidleman and Larry E. Long, *Zoology Dept., Colorado College, Colorado Springs.* *Received May 21, 1958.*

WINTER PREGNANCY OF THE COTTONTAIL

Instances of pregnancy of the cottontail rabbit in winter are cited by Bowers (Jour. Mamm., 36: 303) for Pennsylvania and by Lemke (*Ibid.*, 38: 275) for Wisconsin.

A cottontail, *Sylvilagus floridanus*, shot by a hunter on January 17, 1958, in an orchard of the University of Illinois, at Urbana, was found to be carrying 13 embryos in an advanced stage of development. The mean weight of the embryos was 11.3 gm. (standard deviation = 1.7 gm.), and the mean crown-rump length was 39.7 mm. (standard deviation = 5.2 mm.). This indicates that copulation had occurred about December 28, 1957, and that parturition would have occurred about January 26, 1958.

It is of interest that two of the three winter pregnancies involved large numbers of embryos (Lemke, 10 and Bowers, 5).

A collection of 34 rabbits from central Illinois during the last week in January, 1958, was made to determine if breeding in midwinter was to any degree prevalent. Of 20 males collected only three had scrotal testes indicative of breeding condition. None of the 14 females showed signs of the preparation of the uterus for breeding. None was pregnant or lactating, although five had a parous uterus indicative of breeding during the past summer.

Although northern cottontail rabbits evidently breed occasionally during the winter, the death of the litter under severe winter conditions would act as a curb to any such genetic tendency.—Rexford D. Lord, *Illinois Natural History Survey, Urbana.* *Received April 10, 1958.*

RAFTING OF JACK RABBIT ON KELP

In August, 1955, a black-tailed jack rabbit, *Lepus californicus*, was discovered perched on a pelagic raft of giant kelp, *Macrocystis pyrifera*. The rabbit was removed from the raft after being killed by a sport-fishing boat operator. He did not give the animal's body to the author but permitted a cursory examination sufficient only for identification to species.

The animal apparently had been on the raft for several days as it was very thin and weak. The location of the raft and its occupant was at approximately Lat. 33° 13′ N, Long. 118° 45′ W, 39 miles from the nearest point on the California mainland. This position is in the basin defined by the three Channel Islands—Santa Catalina, Santa Barbara and San Clemente. San Clemente Island was the nearest land, about 15 miles southeast.

No jack rabbits are reported inhabiting any of the Channel Islands. Miller and Kellogg (U.S. Nat. Mus., Bull. 205: 154–155, 1955) report *Lepus c. californicus* as inhabiting the coastal region from the Oregon line south along the seacoast to about Point Conception, Santa Barbara County, California, and *Lepus c. bennettii* as present along the seacoast from Gaviota, Santa Barbara County, south to San Quintín, Baja California.

To reach this position the raft had to originate on the California coast and be carried to sea by some system of currents. In the spring and early summer months north-northwest winds prevail off the coast of California, giving rise to nearshore upwelling. One of the centers of intense upwelling is located at Lat. 35° N. From areas of upwelling, tongues of water of low temperature extend in a southerly direction away from the coast. Between these tongues are areas of warm water extending in toward the coast in a northerly direction. Swirls thus appear on the coastal side of the upwelling center. Toward the end of summer, the upwelling gradually ceases and the more or less regular pattern of currents flowing away from and toward the coast breaks down into a number of irregular eddies. Some of these eddies carry coastal waters far out into the ocean. Other eddies carry oceanic waters toward the coast (Sverdrup, Johnson and Fleming: The Oceans. Prentice-Hall, New York; pp. 724–727, 1942).

Because the rafting occurred during August, it is possible that the rabbit might have been either of the two subspecies. However, its origin from the Point Conception population of *Lepus c. californicus* seems least likely because of the distance and the diminishing of the regular onshore-offshore currents at this time of the year. The other alternative is rafting of the southern form, *Lepus c. bennettii*, on one of the irregular eddies carrying coastal water far out to sea. The shortest possible distance is 39 miles for rafting of the southern form and about 90 miles for one originating in the Point Conception area.

The giant kelp, *Macrocystis pyrifera*, occurs along the entire Pacific Coast of the United States but is most common south of Point Conception, around the Channel Islands, and along the coast of Baja California. The beds of kelp are often extensive and very dense. During storms and other disturbances of the sea, such as heavy ground swells, large masses of kelp break from their holdfasts and drift with the ocean currents. After such an event "kelp rafts" are common on the open ocean. The sizes of the rafts vary from single plants to islands of several thousand plants. The larger rafts are often dense enough to support a considerable weight. The raft occupied by this jack rabbit was over 40 feet long and at least 25 feet wide. It was sufficiently buoyant to easily support the rabbit.—JOHN H. PRESCOTT, *Marineland of the Pacific, Marineland, Calif.* *Received May 7, 1958.*

[Contribution No. 10, Marineland of the Pacific Biological Laboratory.]

WINTER ACTIVITY OF THE EASTERN CHIPMUNK IN MINNESOTA

Eastern chipmunks, *Tamias striatus*, are known to hibernate throughout the northern parts of their range. Bailey (Jour. Mamm., 10: 153–164, 1929) reports that in Sherburne County, Minnesota, they generally go into hibernation in October, although he lists several records for early November. There is a record from New Hampshire for December 1 (Preble, Jour. Mamm., 17: 288–289, 1936), and an observation for central Indiana in February (Test, Jour. Mamm., 13: 278, 1932). In more southern latitudes chipmunks may be active on warm days throughout the winter.

During the winter of 1957–1958, a series of observations was made on the activities of eastern chipmunks on the Cedar Creek Forest and Carlos Avery Game Refuge in northern Anoka County, Minnesota. At least four days every other week were spent in the field.

During the morning of November 24, five chipmunks were seen in the Carlos Avery Game Refuge. At no time during the morning was the temperature above 20°F. This activity followed a heavy snowstorm. Nine inches of snow fell on the evening of November 17, and remained for five days. November 23 was quite warm and much of the snow melted. No chipmunks were seen that day.

On December 17 a chipmunk was seen and collected in a woodlot a few miles south of Cedar Creek Forest. Its cheek pouches contained shelled acorns. Another was seen the next day at Cedar Creek Forest. Both days were quite warm with the temperatures above freezing.

During an extremely mild week in the middle of January, and again in late February, 1958, when temperatures rose to above 50°F., an effort was made to see if the chipmunks had emerged again. However, none was seen during eight days of field work at Cedar Creek Forest, where they are quite common. In the first week in January temperatures had dropped to –10°F. in the Cedar Creek Forest area. It seems likely that the cold weather, and the freezing of the ground, had caused the chipmunks to retire for the remainder of the winter in this part of Minnesota.

By March 24, 1958, chipmunks had emerged from hibernation. Eight were seen and four more heard during the morning. The weather was quite warm, even though patches of snow remained in protected areas. Chipmunks were seen regularly after this date.

The winter of 1957–1958 was one of the mildest on record in Minnesota. This may account for the late activity, as well as the early emergence.—Wayne H. Davis and James R. Beer, *Dept. of Entomology & Econ. Zool., Univ. of Minnesota, St. Paul.* *Received May 29, 1958.*

[Paper No. 3949, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota.]

A METHOD OF TRAPPING GROUND SQUIRRELS

A more effective and efficient method of obtaining live thirteen-lined ground squirrels, *Citellus tridecemlineatus*, than the usual baited live traps is to combine the unbaited live trap with a fence or corral. Instead of placing baited traps in centers of activity the trap, in this case a 4 × 4 ×12 inch National Live Trap, was placed near to and facing a burrow which a squirrel had been seen to enter. A piece of hardware cloth about 9 inches high by 24 inches long was bent to form a circular corral and then placed around the entrance so that the only apparent exit was through the trap. Even though the squirrels can climb, they seldom climb over the top. As a rule it takes about 10 minutes to capture a thirteen-lined ground squirrel by this method. This technique should work with other species of ground squirrels and possibly other burrowing mammals.—James R. Beer, *Dept of Entomology and Economic Zoology, Univ. of Minnesota, St. Paul.* *Received May 5, 1958.*

[Paper No. 974, Miscellaneous Journal Series, Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota.]

CALIFORNIA GROUND SQUIRREL BREEDING IN CAPTIVITY

One adult male and two subadult female Beechey ground squirrels, *Citellus beecheyi fisheri*, were trapped in late July, 1948, at the San Joaquin Experimental Range. They were housed together in an outdoor cage about 6 feet on a side and provided with a nestbox. They were fed rolled oats, occasionally supplemented with other grain, and provided water. They were not fed greens during the winter and spring; the wild ground squirrels in this area consume much green feed during these seasons. They did not hibernate or aestivate, probably because of the frequent disturbance by people passing daily in the vicinity of the cage.

On April 1 of the next year one female gave birth to three young. One of these disappeared 12 days later; eyes of the remaining two were partly open at 24 days of age. The two young were raised to weaning and removed when 40 days old. All 12 teats on the female were suckled by the two young. The other female did not litter. All squirrels used the same nestbox, and all had escaped before the second breeding season occurred.

This is the only instance I am aware of where this ground squirrel has mated and reared its young in captivity. I attribute this success to having started with subadults and to having provided them with a fairly large cage. Also, they were seldom handled.—WALTER E. HOWARD, *Field Station Administration, Univ. of California, Davis.* *Received May 6, 1958.*

PARASITES OF *AMMOSPERMOPHILUS NELSONI*

San Joaquin antelope ground squirrels are infested, as adults, with both ecto- and endoparasites. The young do not become flea-laden until well furred, which is about the sixth week. One of the most characteristic actions of the squirrel is its scratching about the neck and head. Young of the year do not have the endoparasites mentioned below.

Ectoparasites.—The ectoparasites have been collected from two stations, 21 miles apart, one near Cantua Creek, Fresno County, and the other near Panoche, San Benito County, California. These specimens were identified by Dr. G. F. Augustson of Madera, California. Only two flea species were found on those collected: *Thrassis augustsoni* and *Haplopsyllus anomalus*. Hubbard (Fleas of Western North America, 1947: 396) lists five other species found on antelope ground squirrels, but does not state that they were found on this species. *H. anomalus* has been found also on *Citellus leucurus* by Hubbard in Nevada. A tick of the genus *Ixodes* was found on a pregnant female, but this is the only tick found on more than 500 individuals. Ticks of the genus *Ornithodorus* are often found here on the kangaroo rats and wood rats, however. Comparing my results with those of Linsdale (The California Ground Squirrel, 1946: 301–302), it appears that the California ground squirrel, *Citellus beecheyi*, is bothered much more by ticks than is this species. Specimens gathered where both species are found together might give a different result.

As no nest of this squirrel has been found, the number of fleas in a nest is not known. It is known, however, that the female moves her young from the nesting area as soon as they can move. Young examined on April 16, 1946, that were nearly six weeks old, were well supplied with fleas, as were the well-used burrow mouths. Both young and adult captives were seen to work dust through the hair, which possibly helps to discourage ectoparasites.

No sick or dead squirrels have ever been found. Hubbard (op. cit.) states, "Although the San Joaquin antelope squirrel is hemmed in on all sides by plague infected ground squirrels, it has not been found to be plague-positive." Student laboratory technicians examined squirrels taken in 1947, but could find no evidence of disease.

Endoparasites.—The endoparasites have been collected from two stations approximately 30 miles apart, one near Los Banos, Merced County, California, and the other at the Panoche site already mentioned. These have been identified by the late Dr. Harold Kirby and Dr. Marietta Voge of the University of California.

The cestode *Hymenolepis citelli* was the only tapeworm found, and that in only one intestine out of 37 careful, and many cursory, examinations. The host was a lactating female with 7 pairs of teats in use, taken on March 30, 1942. Eight worms were taken from one specimen. This one instance is again different from Linsdale's findings (op. cit., 282–287) in *Citellus beecheyi*.

The same female contained two species of nematodes—*Spirura infundibuliformis*, of which there were 24 females and one male; and *Physaloptera spinicauda*, of which there was one female. One species of Acanthocephala, *Moniliformis dubius*, with eight specimens was found in the same female. Further samples at other places and times gave nothing new.

McLeod (*Canad. Jour. Res.*, 9: 108–127, 1933), in his studies on the parasites of *Citellus*,

found none in the caecum or large intestine, but here roundworms were twice found in stomach, small and large intestine, and caecum. Out of 37 specimens carefully examined, 11 had no internal parasites. These, by weight, were young.

There are neither the species or numbers of parasites here that Linsdale found in *Citellus beecheyi*, yet this is the closest associate of *nelsoni* among the citellids.—ALBERT C. HAWBECKER, *Fresno State College, Fresno, California.* *Received April 1, 1958.*

RENAMING OF *SIGMODON PLANIFRONS MINOR* GOODWIN

Dr. Henry W. Setzer, Associate Curator of Mammals, U.S. National Museum, kindly brought to my attention that *Sigmodon planifrons minor* Goodwin, Amer. Mus. Novitates, No. 1705, p. 1, Feb. 4, 1955, is preoccupied by *Sigmodon minor* Gidley, Prof. Paper 131-E, Dept. Interior, p. 125, Dec. 26, 1922, a fossil form from Arizona. I now propose *Sigmodon planifrons setzeri* as a substitute name for *Sigmodon planifrons minor* Goodwin, Preoccupied. —GEORGE G. GOODWIN, *American Museum of Natural History, New York.* *Received February 24, 1959.*

RANGE EXPANSION OF *BAIOMYS TAYLORI* IN TEXAS

An adult female *Baiomys taylori* and two young were caught on December 14, 1957, 6 miles SSW of Dallas, Dallas County, Texas. This record extends the known range of the species some 180 miles to the north. The mice were found in a nest beneath a piece of tin in a grassy area along the margin of a fallow field. The young were fully haired and firmly attached to the mother's teats. They were not dislodged by her effort to escape.

The topography of the area is one of low limestone hills, supporting a scattered cover of short brush and occasional clumps of prickly pear (*Opuntia*). The population of *Sigmodon hispidus* in this area was high. Investigation of not more than a dozen cactus clumps produced six individuals which were captured by hand in the space of approximately 30 minutes. *Mus musculus* and *Peromyscus maniculatus* were also taken in close association with the *Baiomys*.

Bailey (Biol. Survey of Texas, N. Amer. Fauna 25, 1905) defines the range of *Baiomys taylori* in Texas as the coastal prairies north to Bexar County. Investigation of the literature and specimens located in the Texas Natural History Collection, University of Texas, seems to indicate a definite northward expansion of the range of this species in Central Texas. Taylor and Davis (Tex. Game, Fish and Oyster Comm., Bull. 27, 1947) report a specimen collected in 1936 in broomsedge (*Andropogon*) on the border of pine woods near Huntsville, Walker County. This extended the range some 50 miles north of the eastern segment of Bailey's range map. In recent years numerous specimens have been collected in Travis and Gonzales Counties in Central Texas, again north of Bailey's limits.

Most of the literature references (Blair, Jour. Mamm., 22: 378; Anthony, Field book of North American mammals, 1928) indicate that *Baiomys taylori* has a preference for grassy areas, but recent evidence points to the ability of this species to adapt to somewhat different habitats. Blair (Tex. Jour. Sci., 4 (2), 1952) records captures in mesquite–cactus associations, brush associations and a deciduous forest. In Travis County these mice are found in areas of mesquite brush with only sparse grass. In Gonzales County the authors have trapped *Baiomys taylori* in rocky ledges with a scattered cover of *Andropogon* and in a marshy flat supporting a *Spartina–Baccharis–Phragmites* growth as well as in grassy meadows.

Tharp (Nontech. Pub. Ser. Tex. Acad. Sci., 1, 16, 1939) has outlined the vegetative regions of Texas. The early records indicate that *Baiomys taylori* was restricted to Tharp's Coastal Prairie and parts of the Fayette Prairie and Mesquite–Chaparral regions of South Texas. It is now clear that the species has invaded the Oak–Hickory Association and the Blackland Prairie.

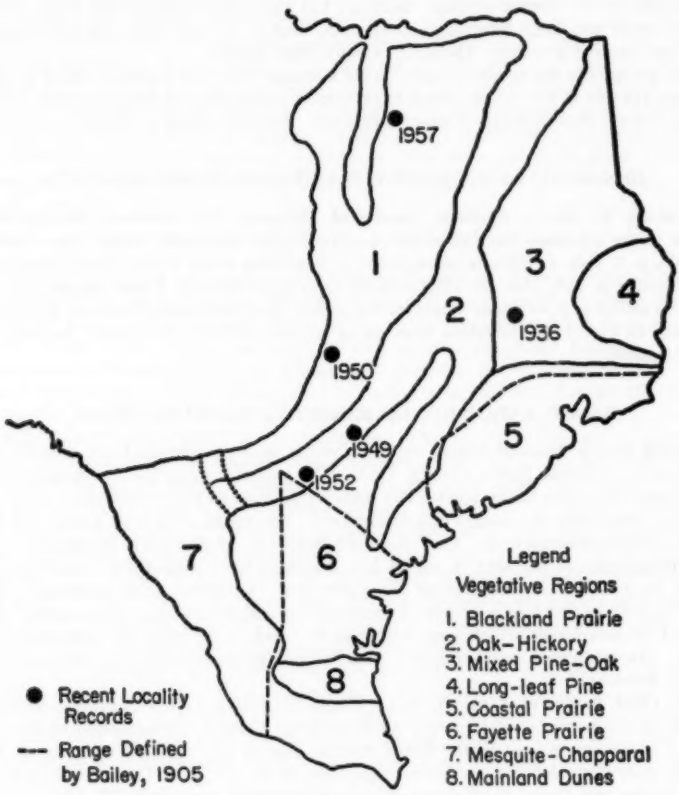

FIG. 1.—Distribution of *Baiomys taylori* in Texas.

The routes of dispersal cannot be determined at this time. However, the Blackland Prairie offers little in the way of a barrier. The ability of the species to adapt to various habitats plus the advent of extensive cultivation has opened the Oak–Hickory Association to exploitation.

This northward extension of a southern species is not unique. It is reflected in several subtropical forms, the more notable of which are *Didelphis marsupialis* and *Dasypus novemcinctus*.—DON HUNSAKER II, GERALD G. RAUN AND JOHN E. SWINDELLS, *Dept. of Zoology, Univ. of Texas, Austin. Received April 19, 1958.*

THE WARREN WOOD RAT IN TEXAS

The localities herein reported are the first known records of the Warren wood rat, *Neotoma albigula warreni*, from the state of Texas. Glass (Proc. Oklahoma Acad. Sci. for 1949: 29) and Blair (Amer. Midl. Nat., 22: 125, 1939) record this subspecies from the northwestern corner of Oklahoma in Cimarron County, approximately 100 miles northwest

of my records. I collected this wood rat at the following localities: 1 mi. S and 10 mi. E of Pringle, Hutchinson County, 8; 2 mi. S and 11 mi. E of Pringle, Hutchinson County, 5; 10 mi. S and 3 mi. W of Gruver, Hansford County, 1.

Glass (loc. cit.) mentions that this rat was taken (Cimarron County, Oklahoma) in open areas, rocky slopes, and mesa tops. I found them only on rocky slopes and arroyos in association with *Neotoma micropus canescens*, seemingly with no ecological separation of the two species. Remains of the Warren wood rat were found, however, in a pellet of a great horned owl which was found under a tree that formed part of the riparian vegetation along a creek.

The identification of the specimens was based on the following skull characteristics, after comparison with specimens of *N. a. albigula* from Pima County, Arizona and northeastern New Mexico: temporal ridges are more angular and bend abruptly medially toward the posterior border of the parietals; the notch between the vomer and the palatal spine is narrower; the antero-internal fold of M_1 extends nearly halfway through the first loop; auditory bullae are smaller. Other differences are smaller size and a lighter, grayer pelage (similar to *N. micropus canescens*) with only a pale buffy wash along the lateral line.—William L. Cutter, *Gruver, Texas.* *Received May 17, 1958.*

EXTENSION OF RANGE OF THE WOODLAND JUMPING MOUSE

The woodland jumping mouse, *Napaeozapus insignis*, has been previously recorded in the United States as far west as the northeastern Minnesota counties of Carlton, Pine and St. Louis (Gunderson and Beer, Mammals of Minnesota, 1953; J. Beer, 1957, *in litt.*). On July 14, 1957, I caught a single specimen in Itasca State Park, Clearwater County, Minnesota, approximately 100 miles farther west.

The animal, a mature female, has the following measurements: total length, 224; tail, 141; hind foot, 31; ear, 15 mm.; weight, 27.1 gm. The mouse had two placental scars and was in lactating condition. It was trapped in a mature red pine stand adjacent to a black spruce bog. This habitat is similar to that recorded in the literature for this species. Small mammal associates were *Sorex cinereus*, *Clethrionomys gapperi* and *Peromyscus maniculatus gracilis*. The specimen is now at the University of Minnesota Museum of Zoology.

Itasca State Park is situated at the southwestern extremity of the boreal forest biome, with prairie to the west and deciduous forest to the south. The coniferous forest stands in this locality probably comprise the western limits of the range of *Napaeozapus*.—Garrett C. Clough, *Dept. of Zoology, Univ. of Wisconsin, Madison.* *Received April 16, 1958.*

ACTIVITY OF *PEROMYSCUS LEUCOPUS*

It is well documented that under normal conditions *Peromyscus leucopus* has a nocturnal activity pattern. Behney (Jour. Mamm., 17: 225–230, 1936) presented evidence that under certain conditions (i.e., under a cover of snow) they were active during the day. Hamilton (Ecology, 18: 256, 1937) reported indications of subnivean activity during the daylight hours. The assumption is that the snow cover offers protection from predation so that they may safely forage during the day.

While engaged in a live-trapping project a situation occurred which offered an opportunity to obtain field data on this theory. A portion of the area being trapped was a sedge marsh (about one acre in size) bordering an oak–hickory upland forest. The sedge growth was abundant and in winter was bent over so that an almost completely closed canopy was formed about 12 inches above the surface. During the trapping periods of January 27–31 and February 24–28, 1958, approximately 4 inches of snow were present, completely closing the canopy. This presented a situation in which the surface was completely covered and yet there was an open space below so that the animals could move about unhindered.

The traps used were of the multiple-catch type and were placed in a grid pattern with

a 40-foot interval. The individuals were marked by toe clipping. The traps were checked twice a day, approximately one hour after sunrise and one hour before sunset.

During the two trapping periods indicated, 14 *P. leucopus* moved into the area from the nearby hardwoods. These individuals were captured a total of 60 times. Of the captures, 59 were during the night and only one during the day. It thus appears that, even under what might be considered ideal conditions for diurnal activity, *P. leucopus* maintained a nocturnal activity pattern.—Lowell L. Getz, *Dept. of Zoology, Univ. of Michigan, Ann Arbor. Received April 21, 1958.*

REITHRODONTOMYS MEGALOTIS AND *UROCYON CINEREOARGENTEUS* FROM WESTERN OKLAHOMA

Two collections of mammals from western Oklahoma by field parties of the University of Kansas Museum of Natural History have resulted in the acquisition of specimens that represent new records for that State.

Reithrodontomys megalotis aztecus J. A. Allen.—Eight western harvest mice (KU 76374–76381), three males and five females, were trapped by Sydney Anderson and Robert L. Packard, along the Beaver River, 3½ miles southwest of Optima, Texas County, Oklahoma, on March 31 and April 1, 1956. These mice were trapped in ungrazed grass on the right of way of U.S. Highway 54, approximately 200 yards north of the Beaver River. The specimens of *Reithrodontomys megalotis* constitute the first record of occurrence of the species in Oklahoma.

Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7: 167, 1952) has recorded *R. m. aztecus* in southwestern Kansas from 8 miles north of Elkhart, Morton County (one specimen), and from 17 miles southwest of Meade, Meade County (two specimens). In New Mexico the subspecies *aztecus* occurs as far east as Espanola (Bailey, N. Amer. Fauna, 53: 164, 1932). Blair (Texas Jour. Sci., 6: 249, 1954), however, referred a single specimen from the Bugbee River, 9 miles east of Stinnett, Hutchinson County, in the Texas Panhandle, to *R. m. dychei*.

The specimens obtained from 3½ miles southwest of Optima are dorsally darker than topotypes of *R. m. aztecus* and paler than topotypes of *R. m. dychei* but more closely resemble *R. m. aztecus* and are tentatively assigned to that subspecies.

Urocyon cinereoargenteus scottii Mearns.—On November 30, 1957, Fred V. Tucker, Jr., gave us a weathered cranium of a gray fox that he obtained on his father's farm, 6 miles north of Kenton, Cimarron County, Oklahoma. This specimen (KU 74553) constitutes the first record of occurrence of *U. c. scottii* in Oklahoma. The nearest records of occurrence of *scottii* known to us are in southern Bent County, Colorado (Cary, N. Amer. Fauna, 33: 176, 1911) and in the Manzano and Sandia Mountains of New Mexico (Bailey, N. Amer. Fauna, 53: 302, 1932). By inference, Bailey (N. Amer. Fauna, 25: 182, 1905) also recorded *U. c. scottii* from Brazos. Palo Pinto County, Texas, when, in his discussion of *U. c. floridanus*, he wrote that specimens from Brazos are "likely to be nearer to *scottii*."—Emil K. Urban and Robert B. Wimmer, *Museum of Natural History, Univ. of Kansas, Lawrence. Received March 6, 1958.*

LYNX FROM WESTERN WYOMING

On March 17, 1954, a Canada lynx, *Lynx c. canadensis*, was taken by the junior author at Hoback Canyon, junction of Cliff Creek and Hoback River, Gros Ventre Range, Sublette County, Wyoming. This male weighed 21¾ pounds with standard measurements in inches of 38⅛, 5, 10¼, and 3⅜. The skin and skull were sent to the Mammal Laboratory of the Fish and Wildlife Service in the U.S. National Museum where identification was made by Viola S. Schantz (pers. comm., 10/18/57). Blanchard also secured on November 27, 1957, a second lynx weighing but 9⅞ pounds with standard measurements in inches of 29⅞,

3⅜, 8 11/16 and 3, at Moose Creek in Teton County, 15½ miles northwest of Jackson. This female kitten has also been sent to the U.S. National Museum.

According to Miss Schantz, there are twelve other Wyoming specimens of *Lynx canadensis* in the national collections, including eleven in the Fish and Wildlife Service and one in the National Museum collection. None of these includes measurements.

Skinner (Roosevelt Wild Life Bull., 4 [2], 1927) wrote, "Probably this cat has always existed in limited numbers in the [Yellowstone] Park, where it frequents the forests of the plateau region. I believe there are about ten individuals present and that the number has not changed materially for years." Blanchard's lynx were secured less than 50 airline miles south of the southern boundary of Yellowstone Park.

Thomas (Bull. 7, Wyo. Game & Fish Dept. 1954) stated, "In Wyoming, the lynx is classified as a predator and may be trapped at any time with no report to the Wyoming Game and Fish Department . . . The animal is not abundant in any area of the state. . . ."

Howard J. Martley, District Agent, writes (pers. comm., 9/30/57): "There are not many true Canada Lynx in Wyoming and those that inhabit the state are found almost all together in the extreme western portions, in the high mountain country. From 1952 until 1955 we know of five positive Canada Lynx catches made by our predatory animal hunters. . . ."

"Two of the Canada Lynx were taken in the vicinities of La Barge and Fontenelle Creeks, and the other three were taken east of Bedford, . . . along Gray's River. Both localities are on the Bridger National Forest in Lincoln County."

A 1957 review of the files of the National Elk Refuge, Jackson Hole, Teton County, failed to reveal records of lynx specimens. Refuge personnel report that alleged lynx tracks have been seen from time to time. The smaller bobcat, *Lynx rufus uinta*, is also a rare visitor to this 23,648-acre area which lies between Sublette County and Yellowstone Park.

The scarcity of lynx records complete with weights and measurements indicates that more Wyoming data concerning this felid would be of value.—Arthur F. Halloran and Willard E. Blanchard, *Bureau of Sport Fisheries and Wildlife, Cache, Oklahoma and Jackson, Wyoming. Received March 20, 1958.*

THE FISHER IN NOVA SCOTIA

The fisher, *Martes pennanti*, once native to the Province of Nova Scotia (Gilpin, Trans. N.S. Inst. Nat. Sci., 1867), was reported by Smith (Amer. Midl. Nat., 40: 213–241, 1940) to be "now probably extinct." Anderson (Nat. Mus. Can., Bull. 102, 1946) does not list Nova Scotia as a province in which the fisher is "known to occur." The following notes are offered to place on record recent changes in status of this species in Nova Scotia.

On July 12, 1947, two male fisher were released on the shores of Tobiatic Lake, in the northeast corner of Queens County. Ten more, four males and six females, were released at the same site on July 2, 1948. These animals were ranch stock.

During the first week of March, 1955, a female fisher was caught in a wildcat trap near Weaver Settlement, Digby County, approximately 25 miles north of the release site. The skull was used to estimate a probable age of "two years and certainly no more than three" (M. W. Coulter, pers. comm., 1955).

Early in December, 1958, a second female fisher was caught in a wildcat snare in Queens County, approximately 25 miles south of the release site. This animal had a perfect set of teeth, sharp and unworn. It appeared to be younger than the previous specimen. The whole animal was donated to the Nova Scotia Museum of Science.

The chronological order of these notes, and reports of fisher tracks and sightings not described here in detail, indicate that this species (though still rare) is reproducing in the wild and spreading from their point of release. It is the opinion of the writer that the fisher is again a part of the fauna of Nova Scotia.—D. A. Benson, *Dept. of Lands and Forests, Truro, Nova Scotia. Received March 10, 1958.*

PIGMY SPERM WHALE IN GEORGIA

Two pigmy sperm whales, *Kogia breviceps* (Blainville), were stranded on the beach at Sapelo Island, McIntosh County, Georgia, on November 7, 1957. They were found, in fresh condition, at 3:30 PM, and were probably stranded on the previous high water at 7:22 AM. External measurements are given in Table 1.

The larger animal was a lactating female. Examination of the viscera revealed an enlarged, thick-walled and spongy uterus. The stomach contained helminths and numerous squid beaks.

TABLE 1.—*External measurements (in inches) of two specimens of* KOGIA BREVICEPS *stranded at Sapelo Island, Georgia, on November 7, 1957*

Measurement	Male	Female
Total length, to notch in flukes	61.5	111.0
Width of flukes	17.0	27.5
Length of left flipper	11.5	18.0
Dorsal fin height	2.75	4.5
Dorsal fin length	6.75	10.0
Snout tip to rear of dorsal base	35.5	66.0
Snout tip to blowhole	6.75	14.0
Snout tip to eye	5.5	16.0
Notch in flukes to rear of dorsal base	23.0	44.5
Notch in flukes to flipper base	48.5	84.0
Body depth at base of dorsal	14.5	21.0
Greatest body depth	15.0	22.0

The smaller animal, a male, was lying about 900 yards south and downwind from the large female. The male was removed to the laboratories of the Marine Institute. It weighed 138 pounds after being held for 48 hours at 4°C.; there may have been some weight loss from desiccation. The umbilicus was completely healed over. The internal organs were not dissected, but squid beaks could be felt through the wall of the stomach. The specimen was preserved and deposited in the U.S. National Museum (No. 306303).

Since the weight of geometrically similar animals increases in proportion to the cube of the length, the weight of the large *Kogia* can be estimated at 812 pounds.

The size of these two animals, when compared with the cow and newborn calf described by J. C. Moore (Amer. Midl. Nat., 49: 117–158, 1953) shows that the Sapelo calf was very young, since the newborn calf reported by Moore weighed 181 pounds and was 64 inches long. On the other hand, the squid beaks in the stomach and the healed umbilicus of the Sapelo specimen remove it from the "newly born" category. The age of the calf cannot be determined with any certainty.—ALFRED E. SMALLEY, *Univ. of Georgia Marine Institute, Sapelo Island, Georgia.* *Received May 29, 1958.*

[Contribution No. 10 from The University of Georgia Marine Institute.]

NOTES ON A FEMALE HARBOR PORPOISE

On November 2, 1956, an adult female harbor porpoise, *Phocoena vomerina*, containing a fetus was brought to us. It had been shot in the head with a .22 caliber rifle the preceding day at Pismo Beach, San Luis Obispo County, California. Since there have been few reports on fresh specimens of this species, a careful examination was made of this one.

Measurements (in cm.) of the adult and the fetus, in that order, are as follows: length, snout to tail notch, 159, 13.5; snout to insertion of flipper, 32, 3.5; snout to center of eye, 15, 2.3; snout to center of blowhole, 19, 1.8; axillary width of flipper, 8, 0.6; length of flipper, 23, 2.3; height of dorsal fin, 10, 0.6; width of blowhole, 3, 0.8; width of flukes, 38, 2.9; tail notch to center of urogenital opening, 55, 4.5.

The adult female was very similar to the male described by Boolootian (Jour. Mamm., 38: 265–266, 1957), having the same black back and white undersides, separated by a mottled gray area along the sides. It differed in that the line from the angle of the jaw to the flipper was more prominent than in the photograph of Boolootian's specimen, and the faint preocular streak was not present. On either side of the urogenital opening were small slits containing the nipples for the mammary glands.

The following observations on the lining of the digestive tract do not seem to have been reported before. The cuticle of the esophagus had a "cobblestone" appearance, while in the first stomach compartment it was heavily rugose. Near the sphincter leading to the second compartment it was distinctly papillose. The first compartment measured about 20 cm. in length and 8.5 cm. in diameter, and both its lining and that of the esophagus were grayish in color.

The second stomach compartment (15.5 by 7.5 cm.) had a lining of heavy, interlocking folds with a smooth, velvety texture, dark red in color. The pyloric compartment, approximately 13 cm. long by 5 cm. in diameter, was separated from the intestine by the pyloric sphincter. The duodenum, a small sac about 3 cm. in diameter, had a slightly folded mucosa. The folds became more pronounced near a slight constriction which separated the duodenum from the rest of the intestine.

The intestine was 20.5 meters long, from pyloric sphincter to anus, with a diameter varying between 1 and 2 cm. No large intestine could be distinguished. The intestinal mucosa was arranged in six longitudinal folds, decreasing from a height of just over 1 cm. near the pyloric valve to about ¼ cm. near the anal opening. Four glandular patches were found on the intestinal wall in the first two-thirds of the intestine, and similar glandular areas were observed in the last half meter. These patches were about a centimeter wide, and from 2 to 6 cm. long. The gross morphology of the alimentary canal agreed with R. H. Burne's description (Handbook of cetacean dissections, British Museum, 1952) and was similar to the illustration on page 668 of Parker and Haswell (Textbook of zoology, Vol. 2, Macmillan, 1947).

Except for a few fish scales in the first stomach compartment, no identifiable food remains were found. Large numbers of as yet unidentified nematodes up to 75 mm. long were discovered in both the first and second compartments, especially near the valves. Fecal smears from the lower portion of the intestine were nearly saturated with microscopic nematode larvae. Cestode fragments were found in the pyloric compartment and in the duodenum.

The diffuse, non-deciduate placenta was 65 cm. long, with a diameter of approximately 10 cm. at the middle, and was of the chorio-allantoic type. Small patches of smooth chorion surrounded by short, branched "villi" were scattered over the otherwise folded surface of the chorion.

The fetus was completely formed, but had a disproportionately large head and blowhole. It was at first thought to be a male, but what was mistaken for a penis was actually a very large clitoris, 5.5 mm. long, which concealed the vaginal orifice. Dissection revealed a bicornuate uterus, oviducts and ovaries. The presence of such a small fetus at this season (November) suggests a summer breeding period in *Phocoena vomerina*, with birth of the young occurring in the spring. Waterman (A laboratory manual of comparative vertebrate embryology, Holt, 1948) reports a gestation period of slightly over 10 months for the porpoise.—Aryan I. Roest, William Thurmond and David H. Montgomery, *Biological Sciences Dept., California State Polytechnic College, San Luis Obispo.* *Received March 10, 1958.*

SURF-RIDING BY ATLANTIC BOTTLE-NOSED DOLPHINS

Caldwell (Jour. Mamm., 37: 454–455, 1956) has summarized data which clearly document the phenomenon that captive Atlantic bottle-nosed dolphins, *Tursiops truncatus* Montague, will play with objects with which they come in contact. Brown and Norris (*Ibid.*, 37: 317, 1956) cited similar behavior for captive Pacific white-sided dolphins, *Lagenorhynchus obliquidens* Gill. From personal observations (Caldwell), and those of others with whom we have talked, this behavior is also exhibited in nature. Gunter (Copeia, 1953: 188–190) has summarized a number of instances of similar play with floating objects exhibited by various species of fish. The "natural curiosity"—in a broad sense, play—of porpoises for floating objects may account, under fortuitous circumstances, for the reports of these mammals coming to the aid of drowning humans (Siebenaler and Caldwell, Jour. Mamm., 37: 127, 1956).

Mariners in all oceans are familiar with the act exhibited by many delphinids of swimming at the ship's bow when it is under way, and often the dolphins are seen to leap entirely out of the water. Apparently having no other significance, these acts may also be interpreted as play. Another example of similar play in nature, in which no foreign objects were involved, is that recorded below; this may, for lack of a more erudite and less descriptive term, be called "surf-riding." We made the two observations independently, and it was not until the Florida incident was prepared for publication that the North Carolina one was recalled.

The coastline in front of Florida's Gulfarium, at Fort Walton Beach on the Gulf of Mexico coast, consists of the sand beach, an adjacent deep slough, and a shallow submerged sand bar about 100 feet off the beach, all parallel. On March 10, 1955, while standing on the third-floor upper deck of the Gulfarium, Caldwell observed, with the aid of 6 × 30 binoculars from a distance of about 250 yards, about 15 Atlantic bottle-nosed dolphins as they leisurely made their way eastward along the coast. The porpoises were obviously surf-riding on the large rollers which were breaking, parallel to the beach, over the bar into the slough. The animals rode the top front of the wave with their heads down and only their dorsal fins and a small part of their backs exposed. The long axis of the body was oriented at right angles to the beach. The water was quite clear and the weather sunny, so that with the advantage of observation from a height it was certain that each porpoise made several "rides" before the school moved out of sight. After each ride the individual swam along the slough for a short way and then turned seaward over and beyond the bar to come in on another roller.

A similar observation was made (by Fields) at Fort Macon State Park, North Carolina, in the summer of 1950. The bottom was relatively smooth in this instance, with no bar or other breaks in contour. About 12 *T. truncatus* were observed swimming westward, parallel to the beach, just seaward of a roped-off public swimming area. After reaching a point slightly beyond this area, the school milled around and soon began to surf-ride singly or in groups of two to four. In the latter case the animals rode the same wave, with their bodies nearly parallel. Each porpoise began swimming beneath the surface of an incoming swell and, as the wave crested and began to break, the animal shot forward until it was riding the forward slope of the wave. Most of the porpoise's head (held down) and much of its back was out of the water—unlike the Florida porpoises. After the wave was "caught," the porpoise was observed to ride it with much the same ease and in the same manner as a human surf-rider. After riding the wave to a point where the water was only about 3½ feet deep, the porpoise stopped and returned to the rest of the school, which was still milling just beyond the breakers. The activities of individual porpoises were not observed, and it was not known whether all animals were taking part in the activity, which continued for about 15 minutes. At the end of this period, the school continued on westward and no additional surf-riding was observed.

It is interesting to note that in both instances people were on the beach and were swim-

ming in the surf in close proximity to the surf-riding porpoises. Apparently in no case was this human activity disturbing to the porpoises.

We wish to thank William W. Anderson, Frederick H. Berry and Jack W. Gehringer, of the U.S. Fish and Wildlife Service, and James N. Layne, of the University of Florida, for helpful suggestions regarding the manuscript.—David K. Caldwell and Hugh M. Fields, *U.S. Fish and Wildlife Service, Brunswick, Georgia.* *Received April 26, 1958.*

MOOSE USING WATER AS REFUGE FROM FLIES

Peterson (North American Moose, p. 191, 1955) and de Vos (Jour. Mamm., 39: 136, 1958) have indicated that observations of moose seeking refuge from insect pests by entering water have been rare. Observations reported here indicate that such behavior may be common in certain situations.

From August 9 to 16, 1954, we descended the Trout River, south of Ft. Simpson, Northwest Territories, by canoe from its source at Trout Lake to its mouth on the Mackenzie River, a distance of about 80 miles. For most of its course the Trout River flows over limestone deposits and is boulder-strewn. It has a moderately steep gradient and is characterized by intermittent shallow rapids interspersed between deeper meanders. Vegetation of the region is comprised of typical boreal forest, a large proportion of which has been burned. The most widespread fires occurred in 1943 and 1944. The burned areas now carry young stands of aspen poplar, canoe birch and willows.

Moose in the area have increased in recent years. An aerial census in December, 1953 indicated a population of one moose per 1.8 square miles in the Trout River area. During the canoe trip, 18 moose were seen. Of these, nine were observed along the banks of the river and nine in the water. Of the latter, six were standing in deep water, and three were lying down in shallows. When observed, all were in a stationary position until disturbed by the approach of the canoe.

On other occasions in the Mackenzie District moose had been seen to enter water to feed on the aquatic plants of shallow lakes. However, no evidence of aquatic feeding was seen on the Trout River. One bull moose was lying down in a shallow river meander in which considerable pondweed, *Potamogeton* sp., was evident. No aquatic plants were noted in the locations where the other moose were seen, largely because the current was too swift and the bottom too rocky to allow such plants to become established.

As we drifted quietly downstream toward a moose it seemed reluctant to leave the water. Invariably, as we paddled into a spot just vacated by the animal, we were attacked by a cloud of blackflies. They could stay with us only a short distance, however, because the speed of the canoe was sufficient to escape them. Specimens of the flies were identified by Dr. G. E. Shewell as *Simulium luggeri* and *Simulium malyschevi.*

Most moose observed in the water held their ears lowered to the sides of the head. It was not a manifestation of anger because the characteristic was noted before moose were aware of our presence. I have on other occasions seen moose, feeding on aquatics in lakes, hold their ears in a similar position as they lifted their heads from the water. I suspect that they may have been closing their ears to the entrance of water in one case and insects in the other.—Donald R. Flook, *Canadian Wildlife Service, Edmonton, Alberta.* *Received April 25, 1958.*

CONTROL OF SMALL MAMMALS WITH SUNKEN-CAN PITFALLS

In trapping small mammals for museum specimens during the past several years, we have made extensive use of sunken cans half filled with water, in addition to the customary snap traps. The large number of mice caught in these pitfalls led us to believe that this method might be useful in reducing populations of mammals in nurseries and orchards where they often do considerable damage by gnawing the bark and roots, especially of young plants.

During the spring of 1957 we carried out a small-scale test to determine the efficiency of this method in reducing a small mammal population on a limited area. A strip of dense roadside vegetation near Pullman, Washington, was selected, consisting of thickets of wild rose (*Rosa*) and snowberry (*Symphoricarpos*), associated with a dense growth of grasses and other herbaceous vegetation. On one side of this 20-foot-wide strip is a little-used unsurfaced road and on the other a succulent stand of planted grass moderately grazed by cattle. A single line of 48 sunken cans was placed through the center of this strip, the cans 10 feet apart and set flush with the surface of the ground. Holes were punched about half way up the sides of the cans and the water kept at or near this level. The cans were the type used for fruit juices, about 4 inches in diameter and 7 inches deep. Alternate cans were baited by smearing a mixture of wet oatmeal flavored with peanut butter on the inside an inch or two from the top.

Each can of alternate pairs was covered by a ¾-inch board about 5 inches wide and 10 inches long, held about 1½ inches above the ground by a strip of wood nailed on each side, leaving both ends open. Since small mammals are often found under boards and other objects lying on the ground, we wished to compare the numbers caught in covered and uncovered cans.

At the time the cans were set out on May 8, 1957, three meadow mice (*Microtus*) were seen running through the grass. Burrows and runways were much in evidence, further suggesting a rather high population level. The trapline was visited once a week, all mammals removed, and alternate cans rebaited. Water was added where necessary to keep the cans about half full.

As shown in Table 1, the weekly catch dropped off rapidly, 31 per cent of the total being taken during the first week and only a little over 5 per cent during the seventh week. About 19 per cent of the animals caught were taken in covered cans and about 81 per cent in uncovered cans, indicating that covers of the type used were a definite handicap at this particular time and place. The possibility still exists that covers of some sort might prove effective for some species under suitable environmental conditions. The denseness of the vegetation on our trapline might have been adequate to give the animals the proper feeling of security, leaving no incentive for seeking additional cover.

Mammals caught in baited cans made up a little over 56 per cent of the total catch, suggesting that baiting might give a slight advantage but probably not enough to justify the extra effort. Insects and other small animals falling into the cans often cause enough putrefaction to produce a strong odor which is perhaps attractive to some species of mammals.

At the termination of our trapping after seven weeks, all cans were eliminated and replaced by standard snap-type mouse traps, of which two were set within 3 feet of each of the 48 stations. All 96 traps were baited with wet oatmeal mixed with peanut butter and exposed for 48 hours. The trapline was visited twice daily. Sixteen mammals were caught the first day and only five the second. The catch was composed of three vagrant shrews, five short-tailed meadow mice and eleven deer mice. The small number taken indicates that the mammal population of the immediate area had been drastically reduced by the preceding seven weeks of trapping with sunken cans. Of course, there is the possibility that some animals migrated out of the area and very likely some moved in.

Adults of the agile deer mice appear to be less susceptible to being caught in sunken-can pitfalls than the clumsier meadow mice. However, juveniles of both species are caught readily; and, if an adequate number of sunken can sets is maintained in an area the year 'round, the gradual attrition should keep the population of small mammals at a very low level. We recommend the use of large numbers of cans on the periphery of the area being protected to intercept many mammals migrating in from surrounding habitats. Sets should be made along fence rows, at the bases of trees or shrubs or in other vegetated sites subject to little disturbance.

Suitable cans are obtainable almost anywhere from eating establishments where large quantities of fruit juices are used. Garbage dumps constitute a rich source of supply. Cans

with a diameter of 5 or 6 inches are probably somewhat more effective than smaller sizes.

Not only are cans available without cost, but the labor involved in maintaining such traps is minimal. Generally, there is no need to visit the traps oftener than once every week or two. Decomposing mice do not seem to effectively repel others; we have often removed six or more in various stages of decomposition from a single can.

TABLE 1.—*Summary of mammals caught in 48 sunken cans at Pullman, Washington, 1957*

WEEK OF	*Sorex vagrans*	*Peromyscus maniculatus*	*Microtus montanus*	*Thomomys talpoides*	TOTALS	PER CENT OF TOTAL CATCH
May 15	7	12	41	–	60	31
May 22	10	5	27	–	42	22
May 29	3	3	20	1	27	14
June 5	6	2	14	2	24	12
June 12	15	1	4	–	20	10
June 19	5	–	5	–	10	5
June 26	5	1	4	–	10	5
Total	51	24	115	3	193	
Covered, baited	3	9	11	1	24	12
Covered, unbaited	3	2	8	–	13	7
Open, baited	28	4	51	2	85	44
Open, unbaited	17	9	45	–	71	37

Since shrews are mainly insectivorous, it might be considered desirable to make some provision for their escape from the pitfalls. This could probably be accomplished by punching a hole ½ inch in diameter at the water line and leaving a crack between the can and the soil at this point. In the western states, the small shrews of the genus *Sorex* could readily escape from such an opening. However, in the eastern states the larger short-tailed shrew (*Blarina brevicanda*) would require an escape hole large enough to accommodate many mice.—GEO. E. HUDSON AND J. DAVID SOLF, *Dept. of Zoology, State College of Washington, Pullman.* *Received April 21, 1958.*

REVIEWS

Kenya Wild Life Society. FIRST AND SECOND ANNUAL REPORTS. Nairobi, Kenya. Pp. 66, 106, illus. 1956, 1957.

The Kenya Wild Life Society was formed late in 1955 to give public support to the Trustees of the National Parks, the Game Department and the wild animals under their protection. Many of us abroad tend to think of Africa as a land of almost infinite faunal riches, but the pressures of a rising population are a serious threat to the future of many of Africa's game species. At the time of the formation of this new society, three major problems required immediate action: (1) native poaching in the Parks and Reserves, (2) administration of the Amboseli Reserve, and (3) administration of Serengeti National Park. Encouraging progress has been made on all three problems during the two years covered by the First and Second Annual Reports of the Society.

Although 20,957 square miles of Kenya are under some form of government control, only 8,569 square miles of this total are included in National Parks. The remaining areas are in National Reserves. National Parks are designated by law as game sanctuaries, but Reserves are not. The International Convention in London in 1933 provided for the designation of Reserves which might be transferred to National Park status "when in the opinion of the authorities of the territory, circumstances permit." Wild animals in National Reserves are preserved "only so long as they do not cause inconvenience to the peasant farmer."

Although the Serengeti problem might be considered a Tanganyika affair, the Kenya Wild Life Society felt that it would provide a test of the attitudes of government toward the entire conception of the status of National Parks of East Africa. The Society felt that the whole of the East African fauna would be affected by any fundamental changes in policy regarding Serengeti, and that these decisions were bound to affect the policies of adjacent territories. By 1951 Serengeti had become a National Park in name only. Prior to 1951 the area was occupied by 7,800 Masai tribesmen and their 322,000 head of cattle, donkeys, sheep and goats. The lack of alternative water supplies outside the park and a cycle of drought years caused more and more Masai to move into the park until, in June 1955, the Trustees of the Tanganyika National Parks "became inexorably forced to the conclusion that the continued presence of the Masai and their domestic livestock within the National Park was irreconcilable with the purpose for which the Park was created." A series of recommendations has been formulated with the help of surveys by scientists from abroad, and there is hope of an equitable solution to the problem in the near future.

There are three National Parks in Kenya. Tsavo National Park covers an area of 8,049 square miles, Nairobi National Park has an area of only 44 square miles, and the mountain parks of Mount Kenya and Aberdares cover an area of 456 square miles. Nairobi National Park, only six miles from the capital city, is a popular attraction; there were 115,000 paid admissions in 1955; but it is unlikely to survive and there is danger of losing much of its wildlife unless adequate protection can be given to Ngong National Reserve, which surrounds it.

The problem of Amboseli Reserve is similar to that of Serengeti. There is heavy competition between the natural fauna and the domestic livestock of the Masai since this magnificent park, at the foot of Kilimanjaro, contains the only water for miles. Work has been started on the development of wells as alternative water for the Masai and there is hope of achieving Park status for an area around Ol Tukai and preserving its water and wildlife.

Marsabit National Reserve is a wild, rugged area of deserts and volcanic features that provides habitat for the endemic reticulated giraffe, Grevy zebra and Somali ostrich and is the best place in Kenya to observe greater kudu. The Society hopes to have at least Marsabit Mountain, a green oasis rising out of the surrounding wilderness of the Reserve, raised to Park status.

At the time the Kenya Wild Life Society was formed, Tsavo National Park was overrun by gangs of native poachers and it was estimated that the Park would cease to be of value, in terms of faunal preservation, within two years unless drastic action were taken. One of the most distressing aspects of the problem was the waste and brutality of the poachers. Giraffes were often killed only for their sinews, which are used for bowstrings, and their tails, which are used to fletch arrows. Wildebeests were slaughtered for their tails, rhinos for their horns, and elephants for their ivory. An active black market in horn and ivory brought very little actual return for the poachers, but had become a profitable venture for the Asians running the market. A common method of poaching is to construct brush fences covering the approaches to water holes, with rope or cable snares set in breaks in the fence. Sometimes the snares are not visited for weeks, causing useless waste of game, and when more animals are caught than can be handled they are hamstrung and allowed to wander about until they can be dealt with later.

The Tsavo elephant population of about 3,000 individuals was particularly vulnerable. Elephant populations can sustain an annual loss of about 10 per cent, but the poachers in

Tsavo National Park were killing an estimated 600 a year, or 20 per cent of the population, in addition to losses sustained by the population through natural mortality. A full-scale campaign against poaching was remarkably successful and the park was virtually cleared of poachers by the end of 1957. As the campaign developed, it became obvious that the poaching problem was even more serious than was originally suspected; 1,280 elephant carcasses and skeletons were found in three safaris lasting nine weeks in one relatively small area. Plans have been made to continue policing the Park by means of airplanes and teams of African Rangers, and it is felt that the preservation of the elephant and other game populations in Tsavo National Park has been assured.

International interest in the activities of the Kenya Wild Life Society is indicated by its list of members. The First Annual Report lists 92 life members of which 67 are from East Africa, four from the United Kingdom, 16 from the United States and one each from five other countries. Additions in 1956 included 32 from East Africa, five from the United Kingdom, 21 from the United States and nine from six other countries. It is encouraging to see how much progress has been made by the Kenya Wild Life Society during the two years covered by these reports, and American mammalogists will certainly follow its future progress with sympathy and interest.—RICHARD S. MILLER.

Krott, Peter. DEMON OF THE NORTH. Alfred A. Knopf, New York. Pp. xv + 260, 40 photos, 2 maps, frontis. February 16, 1959. Price, $5.00.

From early times the wolverine has been a creature of mystery and its ways a source of countless legends. "It is not much bigger than a full-grown fox, but it has the strength of a bear. It usually moves along at a rather clumsy gallop, but the best of the northern long-distance skiers cannot overtake it. The wolverine can't stalk its prey noiselessly; it can't lie patiently in wait; and it can't overtake its victim by superior speed. And yet it is never short of food. Its sight is not particularly keen, nor is its hearing or its sense of smell; and yet even the most skillful and experienced hunter is rarely able to bag it. It gobbles up all kinds of food voraciously, but even strong doses of strychnine cannot kill it. The highest price of any beast of prey in the Far North has been placed on its head, and yet its numbers have hardly decreased." This book will serve to dissipate much of the suspicion and distaste surrounding this intriguing animal, familiarly called the "tupu" by the author.

Peter Krott is an Austrian whose early training was in forestry. A passion for wildlife, and a natural talent for working with animals, led him into the business of breeding and collecting them for zoological parks. This took him to an interesting *paliskunta*, or reindeer round-up, in Lapland, and later on an amusing adventure flying from Helsinki to Prague with an otter, three wolverines, two ibex, three arctic foxes and a few wild geese as his charges. This venture terminated when he turned his efforts to the establishment of a wildlife preserve at Padasyoki, Finland, hoping to attract the tourist trade and enlist support for conservation; here, for two years, he consorted with wolverines, lynx and whistling swans and attempted, with little success, to train moose as draft animals. This interlude was followed by a period in the forests near Älvdalen, in central Sweden, on an intensive study of wolverines; the work was supported by the Swedish government, but not always by the sympathetic efforts of the natives. Krott is now engaged on a similar five-year study of the Alp bear, under the auspices of the Italian province of Venezia Tridentina.

The wolverine, in the wild state, is a solitary creature, alert and curious, never still except when asleep. It travels over wide territories, moving in vast serpentines and choosing rough terrain—the most difficult for pursuers. It requires plentiful water, and revels in snow. It is an able climber and swimmer, but is clumsy and noisy except when traveling on snow. This it does during most of the year and on its oversized feet it can easily overtake a moose, successfully defy a wolf, or force a bear to give way before it. It delights in killing everything within its reach—"just like that, and with no malice, or even any particular intent"—and only the hedgehog (or porcupine in America) is a real menace.

Most of Krott's wolverines were raised from infancy and kept as household pets. In all, he worked with thirty-one of them and his observations contribute much to our knowledge of animal psychology. They were highly intelligent, quick to learn, playful and gentle as kittens with those to whom they were accustomed. A few unguarded statements have crept into the text, e.g. (p. 56) that "Like all beavers living in inhabited neighborhoods, this pair had built its lodge below ground and not openly above the lake;" or (p. 149) that the wolverine "does not flee the neighborhood of man" as do deer. In view of these inaccuracies, one reads (p. 85) with a grain of salt that "tupu bites never fester even when the skin is broken. Their spittle seems to have strong antiseptic qualities." But for all this, there is a wealth of new information about wolverines here. Even the most severe skeptic cannot ignore the evidence portrayed in the pictures. They present an amazing new side to this much maligned and misunderstood denizen of the north.

The original German has been translated by Edward Fitzgerald with as much feeling as were the Persian verses of Omar Khayyám by an earlier Edward Fitzgerald. The reader feels the moods of the Far North, as in the description of "a sparse wood which consisted almost entirely of arctic spruce, for no other kind could have lived there; the sunken ground lay wide open to the northern storms. . . . It was a sad, gloomy, and mysterious landscape. . . . There was such peace and stillness on the air as can only be found where there are no human beings." Somehow the wolverine seems to typify these wild, beautiful, northern forests more than any other animal.—RICHARD H. MANVILLE.

Graf, William. THE ROOSEVELT ELK. Port Angeles Evening News, Port Angeles, Wash. 105 pp., illus. 1955. Price, $1.50 (paper).

To date, Graf's monograph represents the most intensive research on this subspecies. It is based primarily on observations of free-living and unrestricted animals in their natural environment. Although the findings were obtained from field studies in Oregon, data from research in other areas were recognized and add to the completeness of the publication.

Since the author is an accepted ecologist, it was rewarding to find this pamphlet emphasizing the life history of the Roosevelt elk. The reader can quickly obtain pertinent data on the elk's early historical records, range, distribution, habitat and behavior, as well as information on food habits, reproduction, development, mortality and present status in game management. One outstanding chapter discusses social habits and behavior. In the discussion on the rut, there may be found detailed systematic accounts of the physiological state, age, rut wallows, young bull habits, fights and, in addition, more data on the act of breeding, callings and sign posts. Such thoroughness in reporting social habits reminds one of similar studies conducted on big-game animals in Europe. Possibly reports on behavior in the life history of North American game animals have been underemphasized in the past, and a new awareness of its importance has been stimulated.

There are two chapters pertaining to past and present practices of elk management, including one detailed section on hunting. The importance of limiting factors is discussed and the problem of "poaching" is dealt with in detail. Along with this are some recommended practices for increasing Roosevelt elk herds.

There appear to be only a few minor errors in the pamphlet, such as on page 104 where no further information is included after listing an author under references. The small print is decidedly a disadvantage. This is a combined result of monetary values and the Port Angeles publishing technique, which is primarily for newspaper work. The price is moderate when considering what is received for, although small in size because of print, the booklet contains close to 50,000 words. A point of discussion for many persons will be the apparent lack of quantitative biological data. This becomes a touchy criticism, for the writing was built around social behavior—a study which does not lend itself as readily to tabular data as many other research projects.

A word of appreciation is decidedly due the author for making his research findings

available to fellow workers. Only too often, the obstacle of publication hazards prevents excellent pieces of work from reaching what should be the completion of a research project —a published report readily available to others in one's profession. Another merit of the publication is the many pen and ink drawings done by Patricia Hansen; this work will definitely establish the artist as one accomplished in portraying naturalism in wildlife. —JAMES D. YOAKUM.

Rutstrum, Calvin. THE NEW WAY OF THE WILDERNESS. The Macmillan Co., New York. Pp. x + 276, illus. 1958. Price, $4.50.

This is a book about traveling and living in the wild. The title may be catchy, but its meaning is elusive, and there is much in these pages that is not *new*. A foreword is followed by 16 chapters and a 3½-page index. The 80-odd illustrations by Les Kouba are very good, although some (pp. 107, 123, 126 and 156) could have been omitted without detracting from the text.

In Chapter One, "The Wilderness Challenge," the author sets up "straw men" in the image of the inexperienced wilderness travelers and then lectures them severely on the errors that result from inexperience. Fortunately the chapter is short. Dogmatic statements coupled with a less than lucid writing style may at first get a reader's "back up." As the chapters unfold, however, the lack of literary polish lends a note of sincerity and unpretentiousness which overshadows minor differences of opinion on the text. That wolves do not run in packs will be challenged by the researcher and trapper alike. The *Journal of Mammalogy* (28: 294–295, 1947) records an authentic case of a wolf attacking a man, which example Mr. Rutstrum did not find in spite of his "long research."

He covers everything from camping on sea ice to cooking pork chops. Some chapters and sections of chapters are excellent; others shade to the opposite end of the spectrum. The chapters on canoeing, wilderness camping equipment, clothing and personal equipment, wilderness cooking, and wilderness recipes and menus find the author at his best. I can wholeheartedly endorse what he says about the merits of a Dutch oven, the importance of an adaptable field tent, the utility of the Duluth pack, the necessity of a comfortable night's rest in camp, the precautions needed to make wilderness travel successful, etc. Responsive notes will doubtless be struck for other readers on other points.

Some sections of the book are weak in both commission and omission. For example, the material on field cameras could best have been referred to a suitable reference; aerial photographs are not mentioned, but have been used with considerable success in wilderness travel; a sheet for one's sleeping bag is, I feel, essential and not a frill for the "fastidious"; a support behind one's head (e.g., blanket, jacket, sack of flour, etc.) will make tumpline carrying considerably easier; a whole series of insecticides and repellents other than DDT are now available; and lastly, a No. 1 lead pencil is apt to prove the *worst* rather than best writing device for field notes.

Mr. Rutstrum implies that he designed the use of guy ties to keep the walls of an A-tent from sagging. I will not dispute the claim, but Abercrombie & Fitch has been selling such a tent with guy ties for about fifteen years—and perhaps longer. It is strange that snaring and trapping of animals for food are passed over lightly in the chapter on survival, when a long but inadequate discussion is given on the edibility of roots, nuts and berries.

Any reader who has spent one night under the stars in a sleeping bag will find kinship with Mr. Rutstrum. Some may challenge details, but no one will dispute that his is a knowledge gained from experience on the trail. While I feel he may be oversold on aluminum canoes and on a varied wilderness diet, I would have no hesitance in accepting the author as the leader of a wilderness journey. In spite of some shortcomings, this is a worthwhile book that will give something to the most seasoned wilderness traveler, and much to the novice. My copy will be put to good use.—ROBERT A. MCCABE.

Gilmore, Raymond M. THE STORY OF THE GRAY WHALE. Privately printed, San Diego, Calif. 16 pp., 9 illus. December 24, 1958. Available at 50 cents per copy from the author, Museum of Natural History, Balboa Park, San Diego.

All too seldom do we receive a good descriptive paper on whales, particularly one concerned with behavior and ecology. In this brief pamphlet we have such a treatment of one species, *Eschrichtius glaucus*, of the North Pacific. Dr. Gilmore, with a background of experience with the whaling fleet, and with field trips taking him from California to Maine, from Alaska to Antarctica, and to the tropics of South America, is one of the few men competent to write such a piece. He here presents a lucid picture of the gray whale, based largely on observations in the waters about Baja California from 1953 to 1958.

This leviathan, one of the baleen whales, may reach a length of 50 feet and a weight of 40 tons. Unlike most whales, it shows an inclination to frequent the shallow waters near land, especially for breeding. In the lagoons and bays of Lower California over 95 per cent of the population, estimated at about 4,400 in 1957, congregate from January to March to have their calves and to mate. There follows a northward migration of 6,000 miles or so to the waters of the western Bering Sea and adjacent Arctic Ocean, where the herd feeds on plankton from June to October. This is one of the longest migrations of any mammal, accomplished largely without feeding or sleeping, at a speed of about 4 knots, or 80 nautical miles a day. And in this course it travels mostly beneath the water, at depths as great as 400 feet, but with a rhythm of alternate deep and shallow dives which brings it to the surface every 3 to 7 minutes to breathe and exhale as a foglike vapor the moisture-laden air from the lungs. To evade detection, the gray whale may surface with only the nostrils, exhaling slowly and quietly without a spout; or, in sheer exuberance, it may "broach" or leap clear of the water.

"The gray whale is not a highly social animal and you will rarely see a group, or pod, as large as ten." The most common social group is the trio, a female and two males. This situation the author explains by the biennial reproductive habits of the species. Only once in two years, after a gestation period of nearly 12 months, does the cow bear a single 1,500-pound calf, weaned some five months later. If, as seems reasonable, there is a 50 : 50 sex ratio, then there are twice as many eligible males as females each winter. "The trio is thus the answer to the excess of males; and, no more equable solution to the eternal triangle could have been devised."

This and much more the author presents in entertaining style. Although marred by numerous typographical errors, the story is an entrancing one. This California herd, a center of human interest since 1840, was hunted for its oil and baleen until all but annihilated by 1890. But it was resilient and, under the protection extended it by an International Agreement in 1938, has responded. We are left with the hope that, if no harvest is taken and if the breeding grounds remain inviolate, there may some day be a herd of 25,000 of these largest and most famous winter visitors to southern California. —RICHARD H. MANVILLE.

Hubbs, Carl L., *ed.* ZOOGEOGRAPHY. Publ. No. 51, American Association for the Advancement of Science, Washington, D.C. Pp. x + 509, illus. 1958. Price, $12.00.

This volume, appearing on the centennial of their great contributions to biology, is fittingly dedicated to the memory of Charles Darwin and Alfred Russel Wallace. Its contents, however, are more provincial in scope and less comprehensive in general conclusions than were theirs. This book comprises papers presented at two symposia in 1957: one on "The Origins and Affinities of the Land and Freshwater Fauna of Western North America," under the prime auspices of the Pacific Section of the Society of Systematic Zoology, at a joint meeting of the AIBS and the Pacific Division of the AAAS, at Stanford University in August; and the other on "Geographic Distribution of Contemporary Organisms," at the Indianapolis meeting of the AAAS in December. Fifteen of the twenty papers originally presented are

here included. It is regrettable that the others, e.g., by Alden H. Miller on birds and by Robert C. Stebbins on amphibians and reptiles, are represented only by abstracts.

This is not truly a zoogeography, as reflected in the title, but rather a group of detailed treatises on distributional problems, chiefly in western North America. Of special interest to mammalogists are the papers on "Evidence from Fossil Land Mammals on the Origin and Affinities of Western Nearctic Fauna," by Donald E. Savage; on "The History and Affinities of the Recent Land Mammals of Western North America," by William H. Burt; on "Distributional Patterns of Vertebrates in the Southern United States in Relation to Past and Present Environments," by W. Frank Blair; and on "Pleistocene Ecology and Biogeography of North America," by Paul S. Martin. Other chapters are concerned with different animal groups, or with the companion fields of geomorphology, paleoclimatology, paleontology and physiology.

Composed as it is of papers prepared independently, and reflecting the interests and viewpoints of the several contributors, this volume lacks the broad coverage, the attention to general principles, and the uniformity of treatment to be expected in a textbook. Nor is it intended as such, despite the title. It is, rather, a rich storehouse of information on zoogeography and some of its cognate fields, often scholarly in nature, ranging from thoughtful commentaries to detailed summaries of intensive research. An introduction to Part II, by E. Raymond Hall, and a final chapter on "General Conclusions," by Carl L. Hubbs, serve to point up the highlights and bring the whole into focus. The terminal indexes are only of authors and of scientific names. References are appended to the individual papers. Students of animal distribution will find here many stimulating ideas and useful data, and will conclude, as does the editor, that countless fascinating problems persist, even outside the Golden West, and that "zoogeographical gold is where you find it."—RICHARD H. MANVILLE.

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COMMENTS AND NEWS

PROPOSED ORGANIZATION OF VERTEBRATE MORPHOLOGISTS

The Vertebrate Symposium, a scheduled part of the December, 1958 meeting of the American Society of Zoologists, was highly successful. Thirty-five papers were presented on a wide range of topics, and approximately 80 to 150 persons attended each of the four sessions. The symposium was organized by Professor A. S. Romer primarily to bring together those doing research in vertebrate morphology, and to find out if there is sufficient interest in this subject to form a Section of Vertebrate Morphology within the American Society of Zoologists. Since considerable enthusiasm was expressed in favor of such a Section, an Organizing Committee was set up to investigate the matter further, and to take the necessary steps to establish the Section. The committee consists of Dr. Richard J. Baldauf, Texas A and M College; Dr. Harvey I. Fisher, Southern Illinois University; Dr. Perry W. Gilbert, Cornell University; Dr. Alfred S. Romer, Harvard University; Dr. Bobb Schaeffer, The American Museum of Natural History, *Chairman*.

Since the next meeting of the American Society of Zoologists will be August 30 to September 3 at Penn State, it is the opinion of the Committee that sufficient time is not available to organize the Section before this meeting. Several sessions on vertebrate morphology are planned for this meeting, however, and an organization meeting will be held in conjunction with the morphology sessions. The aims and purposes of the Section will be discussed, and a petition for organizing the Section will be circulated. Proposed Bylaws for the section will be presented. All members of the Section must, of course, be members of the American Society of Zoologists.

The response at Washington indicates that a Section of Vertebrate Morphology is both highly desirable and feasible. If you are engaged in research on any phase of vertebrate anatomy or embryology (comparative, descriptive, functional), on problems of vertebrate evolution, or the use of morphologic criteria in systematics, or on any other subjects which could properly be fitted into the scope of the proposed section, your comments and active participation in the Vertebrate Morphology Sessions of the American Society of Zoologists are earnestly solicited.

BROCHURE AVAILABLE

During the recent meeting of the Society in Washington, a four-page brochure was distributed at the banquet on June 23. It contained a picture of the founders at the first meeting in 1919, portraits of the 21 Presidents, and a brief historical sketch of the organization of the Society. Surplus copies of this brochure are available at $1.00 each postpaid. Address requests to Miss Viola S. Schantz, Room 61, U.S. National Museum, Washington 25, D.C.

SPECIMENS FOR FOOD HABITS STUDIES

About 20,000 specimens of bird and mammal stomach contents from the Food Habits Collection of the Patuxent Research Refuge, U.S. Fish and Wildlife Service, have been transferred recently to the Department of Zoology, University of Massachusetts, Amherst, Massachusetts. These will be available after February, 1960, to qualified research personnel for specific food habits studies. Address inquiries to Dr. L. M. Bartlett, Associate Professor of Zoology.

THE SEA OTTERS OF AMCHITKA

A unique film of the above title, made in the western Aleutians by H. Robert Krear in cooperation with the U.S. Fish and Wildlife Service, is available from Thorne Films, Inc., 1707 Hillside Road, Boulder, Colorado. The details of the life history and behavior of the sea otter are ideal for presentation to groups in biology, conservation or ecology at any level. The 16-mm. sound film is in color; running time is 45 minutes. Price, $450 per copy; rental, $20.

NOMENCLATURE OF MAMMALS

In 1953 there appeared in this Journal (vol. 34: 285) a plea by Hoffmeister for uniformity of common names, together with the suggestion that the names in Burt's FIELD GUIDE TO THE MAMMALS (Houghton Mifflin, 1952) be adopted as standard. Certain objections to this proposal were voiced in this Journal (vol. 35: 142–144) by Rodeck in 1954. In Palmer's THE MAMMAL GUIDE (Doubleday, 1954) there appears another set of vernacular names, agreeing in some cases and differing in others from those of Burt. In 1957, under the chairmanship of Hall, a subcommittee published (Univ. Kans. Mus. Nat. Hist., Misc. Publ. 14: 1–16) another set of vernacular names for North American mammals. In Blair's chapter on Mammals in VERTEBRATES OF THE UNITED STATES (McGraw-Hill, 1957) and in the recent MAMMALS OF NORTH AMERICA by Hall and Kelson (Ronald, 1959) may be found still other treatments. Disagreements continue to exist—as will always be the case—but these attempts to stabilize the common names of mammals are commendable. In all cases, these names refer to *species* or larger groups; it is not the current practice to dignify *subspecies* with distinctive vernacular names.

Our present concern, however, is less a matter of terminology than of orthography. We use the American in preference to the British spelling, e.g., *gray-colored* instead of *grey-coloured*. Compounding of nouns varies greatly, and in general follows the principle that, with increased familiarity, the evolution is from separate words to hyphened forms to a solid word. Thus WEBSTER'S NEW INTERNATIONAL DICTIONARY (2nd ed., 1957) gives *musk ox* and *muskrat*; *jack rabbit, jack-spaniard* (a wasp) and *jacksnipe*. In current mammalogical literature one may find such variations as *jack rabbit, jack-rabbit, jack "rabbit"* and *jackrabbit; deer mouse, deer-mouse* and *deermouse; wood rat, wood-rat* and *woodrat*. Only *cottontail, muskrat* and *woodchuck* show a high degree of consistency. Compound adjectives are usually hyphened and retain the adjectival form, but derivative nouns may be closed up; thus, *white-tailed deer* or *whitetail*. With continued usage an adjective may lose the terminal *-ed* and become a modifying noun, as above. In such cases (pronghorn, ringtail, cottontail, bighorn) the new compound noun becomes the name proper, and the latter portion of the name (antelope, cat, rabbit, sheep) should be dropped. Examples of the preferred treatment are listed below:

bovid	free-tailed bat	microtine	red-backed vole
cotton rat	hog-nosed skunk	musk ox	star-nosed mole
deer mouse	jack rabbit	pigmy shrew	white-footed mouse
dormouse	leaf-chinned bat	pipistrel	wood rat

Contributors are reminded of the note in this Journal in 1951 (vol. 32: 137) concerning the spelling of patronymic scientific names. Trivial names are formed by adding, to the exact name of the person concerned, the appropriate suffix in the genitive case: *-i* for a man (*bairdi, ordi*) or *-ae* for a woman (*canfieldae, edithae*). In accordance with the recommendations of the International Commission on Zoological Nomenclature (Bull. Zool. Nomen., 4: 205–209, 1950), the Journal attempts to adhere to this practice.—ED.

CORRECTION

In the recent LIST OF MEMBERS published in the Journal (May, 1959) the asterisk indicating a Life Member was inadvertently omitted before Robert T. Hatt on page 290.

DEATHS REPORTED

Ira D. George, April 2, 1959
S. Paul Jones, January 26, 1959
Lawrence E. Hicks
Gustavus Pope

PERSONAL NOTICES

This space is available to members of the Society for brief notices of interest to mammalogists. Copy should be sent to the Editor by the 10th of the month preceding publication. Rates for single insertion are 25 cents per line or portion thereof. Notices will be continued in each issue unless cancellation is received a month before publication or unless specified in original order. Bills will be rendered by the Secretary-Treasurer following publication.

FOR SALE—*Japanese "Mist" Bat Nets.* Send for price list. W. B. Davis, 254 F.E., College Station, Texas.

FOR SALE—*Live desert rodents.* Send for information and price list. Keith E. Justice, 44 W. Rillito St., Tucson, Arizona.

KEY TO THE SKULLS OF NORTH AMERICAN MAMMALS, by Bryan P. Glass, has been reprinted and may be ordered from the Research Foundation, Oklahoma State University, Stillwater, Oklahoma. Price $2.00 as in the past.

FOR *Sherman Live Traps* write H. B. Sherman, P.O. Box 683, De Land, Florida.

FOR SALE—*Transactions San Diego Society of Natural History,* complete set, Vols. 1–11 with Vol. 12 in progress, newly bound in blue buckram, $125. L. M. Huey, Natural History Museum, Balboa Park, San Diego 1, Calif.

POSITION WANTED—*Teaching and research.* M.A. in field zoology; qualified in general biology, zoology, ornithology, mammalogy, natural history and conservation, also much library experience in these fields. Seacoast or Southwest preferred, but any offer earnestly considered; available summer or fall 1959. Daniel McKinley, Dept. Biology, Bowdoin College, Brunswick, Maine.

FOR SALE—Packard, Cave fauna N. Am., $7.50; Allen, Whalebone whales N. Eng., $7.50; J. A. Allen, Smaller spotted cats, $2.50; N. Am. opossums, $2; Kellogg, Tenn. mammals, $1; Miller, Families and genera of bats, $5; M. and Allen, Bats Myotis and Pizonyx, $5; H. Allen, Bats N. Am., $4; Osgood, Papers on mammalogy, $4; Poole and Schantz, Catalog type specimens, $4; Vladykov, Marsouin blanc, nourriture mars. blanc, $2 ea.; Tate, Mammals E. Asia, $4; Carter, Hill, Tate, Mammals Pacific, $3; Anderson, Canadian Recent mammals, $2.50; Mearns, Mammals Mexican border, $7.50; Philippines—Hollister, 1913, $1; Miller, 1910, $1; Mearns, 1905, $1; Barbour, Lawrence, Peters, 1939, $1.50; de Beer, Vert. Zoology, $5. Postage prepaid. *Wanted*: Grinnell, Storer, Animals Yosemite; Dill, Life, heat, altitude. Raymond J. Hock, Arctic Aeromedical Lab, APO 731, Seattle, Wash.

WANTED—*North American Faunas* concerning Mexican mammals; advise of asking price. Ticul Alvarez S., Calle 27, No. 71, México 18, D.F., México.

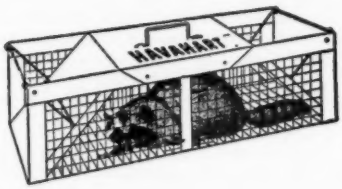
WANTED—Scammon, Marine mammals of the northwest coast of North America; Scoresby, An account of the Arctic regions; Eschricht, Reinhardt and Lilljeborg, Recent memoirs on the Cetacea. Dale W. Rice, U.S. Fish & Wildlife Service, Sand Point Naval Air Station, Building 192, Seattle 15, Wash.

FOR SALE—*The Wolf in North American History* (Caxton, 1946), now out of print, at $2.15 per copy postpaid in U.S., from author, Stanley P. Young, Room 58A, U.S. National Museum, Washington 25, D.C.

WANTED TO BORROW—Slow motion moving-picture sequences of hard-running cursorial animals taken side-on to the camera are needed for motion analysis studies. Any mammal—pronghorn and African antelope particularly desired. Films carefully handled. Expenses paid. Milton Hildebrand, Dept. of Zool., Univ. of Calif., Davis, Calif.

WANTED—*Journal of Mammalogy*: Vol. 4, No. 1; Vol. 27, Nos. 1 and 2; Vol. 36, No. 4. W. C. Glazener, P.O. Box 1396, Sinton, Texas.

HAVAHART HUMANE ANIMAL TRAPS



The *Allcock Manufacturing Company* has a large variety of humane animal traps. They have many sizes of live traps for those who are interested in catching the animals unharmed. The HAVAHART TRAPPING BOOKLET will be sent free of charge to anyone who requests it from the *Allcock Manufacturing Company, Ossining, New York.* HAVAHART traps have been used successfully by many who have been doing live-trapping experiments on small mammals. Write for the free booklet today.

NOTICE

Members are reminded that changes of address are not reflected in the mailing of the Journal unless received by the Secretary-Treasurer by the 1st of the months of issue—February, May, August and November.

STYLE SHEET

A four-page Style Sheet with specifications, sample pages and examples of Journal format is available by sending a request and a self-addressed stamped envelope to the Editor.

SUGGESTIONS TO AUTHORS

The *Journal of Mammalogy* publishes original papers with significant new material on any phase of the science of mammalogy. While authors need not necessarily be members of the society, it is suggested that those doing serious work in this field consider carefully the desirability of affiliating with the American Society of Mammalogists.

Papers are generally published in order of receipt with some exceptions at the discretion of the editor. Papers over 20 printed pages in length are rarely published because of cost and space limitations. When subsidized, however, such papers may occasionally be published. Photographic and tabular matter, likewise, will be accepted only when necessary to the exposition of the paper and when the data or point presented are not repeated in the text.

A neat, carefully prepared manuscript is assured more favorable consideration by the editors. It also expedites processing and is more likely to appear in print as the author intended it. Toward this end, the following suggestions are offered as a guide:

All manuscripts should be typewritten on one side only of a good quality white bond paper, preferably 8½ × 11″ in size. All material—*including titles, by-lines, headings, tables, extracts, references and legends*—should be double-spaced. Carbon copies will not be accepted, nor will originals on onionskin or highly glazed paper. Pages should be numbered consecutively in the upper right corner. Tables (with captions) and legends for figures and plates should be typed on separate pages following the text. All margins should be at least 1½″ wide. Do not mark for typography, except to indicate *italics* by underscoring.

Titles should be brief as an aid to bibliography. Usually less than ten words will suffice. Avoid citing scientific names in the title but incorporate them early in the text.

Acknowledgments and reference to sponsorship and contract number are included in the text. Avoid footnotes hung from the text. Note author's affiliation at the end of the article. This should be concise—it is intended to furnish his current address, not his biography.

References, when less than six in number, should be inserted in parentheses at appropriate spots in the text; they should include author, publication, volume, pagination and year, but not title unless a book. More extensive references, arranged alphabetically by author and with title included, are grouped under "Literature Cited." In general, our bibliographic style follows the suggestions made in the A.I.B.S. Bul., 2 (2): 21–23, 1952.

Standard abbreviations are used freely, particularly in tables and with units of measure, *e.g.*, 5.7 mm., 12 cc., 23 lb., 5 hr., 35 mph, 20°C.

Tables should be typed on separate terminal pages and should be arranged as simply as possible to fit Journal page size. It is not always necessary to present all data at hand; the author should exercise some judgment as to what data are essential. Include the units of measure employed. Do not insert rules except in box heads, and then only lightly in pencil.

Figures include black-and-white drawings and graphs reproduced as line cuts. Originals should be submitted. Some reduction is desirable, but a drawing need not be more than twice the size of the intended cut. If a scale is included, anticipate its reduction in size. Labels also must be planned to be easily legible when reduced. All lines must be solid black, not gray. Graphs may be made on paper with pale blue lines which will not reproduce.

Plates are photographs reproduced as halftones. The originals must be sharp, with high contrast, and printed on glossy paper; they should be submitted unmounted. A size of 4 × 5″ is ordinarily most convenient. Each should be identified by a light pencil notation on the back. Cropping to remove nonessential portions is often desirable.

A summary, brief and informative, is advisable at the end of major papers.

Authors are urged to consult recent issues of the Journal for examples of styling. *A Manual of Style,* Univ. of Chicago Press, is a standard guide. The Government Printing Office *Style Manual* is especially helpful on capitalization. The final authority for spelling is Webster's *New International Dictionary,* unabridged. Webster's *New Collegiate Dictionary* is adequate for most purposes; it contains a useful appendix with rules for punctuation, capitalization, hyphenation, preparation of copy, and proofreaders' marks. Fowler's *Modern English Usage* is a sound and entertaining reference on grammar and writing in general.

Proof should be read word for word immediately upon receipt and returned promptly, with manuscript, *to the editor.* Errors should be corrected in the margin, but galleys are not the place for widespread corrections by the author. Essential changes or additions are best added at the end of a paragraph, or inserted as a new paragraph. Extensive changes from the original copy will be charged to the author. Cuts should be identified by number, the desired placement of tables and figures indicated in the margin and, where it is not evident, each cut should be labeled TOP on one side.

Reprints may be ordered directly *from the printer* when galleys are checked. An order form is supplied with the proof.

Abstracts of major papers should be prepared and returned with corrected proof.